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ABSTRACT

This seven-chapter report presents information on the 1980 assessment of students' science performance in the province of Manitoba. Chapter I describes the nature of and steps involved in the assessment. Chapters II, III, and IV present, analyze and discuss achievement and attitude results for grades 5, 8, and 11, respectively. Achievement results are in these categories: knowledge, comprehension, application for three content areas (earth and space science, biological science, and physical science); higher cognitive levels for all three content areas; basic processes; integrated processes; safety; and the nature of science. Attitude results are in these categories: interest in science and science-related activities, attitude toward scientists and science-related areas; and interest in science as a career. Chapter V compares trends in goal achievement (related to achievement result categories), achievement differences according to sex, and trends on common achievement and attitude items. Chapter VI presents results of separate surveys of fifth-, eighth-, and eleventh-grade teachers on their teaching practices, degree of implementation of recently developed science curricula, background, and other areas. (Survey instruments are included in appendices). Chapter VII summarizes findings and offers recommendations related to grade level and to achievement/attitude result categories. (JN)

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MANITOBA
SCIENCE ASSESSMENT PROGRAM
1980

FINAL REPORT

SE 045 982

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MANITOBA
DEPARTMENT OF EDUCATION

MANITOBA SCIENCE ASSESSMENT PROGRAM 1980

FINAL REPORT

A REPORT OF THE
MEASUREMENT AND EVALUATION BRANCH
DEPARTMENT OF EDUCATION
PROVINCE OF MANITOBA

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PREFACE

The Science Assessment Program was the third assessment conducted by the Measurement and Evaluation Branch. The assessment, conducted in November, 1981, followed procedures similar to those for the Reading Assessment Program of 1979-80, and provided an indication of the Science performance of students in Manitoba.

Purposes

As with the other programs, the Science Assessment was intended to provide a broad base of accurate and current information on the performance of students in Manitoba. Stated briefly, the purposes of the provincial assessments are:

1. To provide benchmark indicators about the level of student achievement in the Province of Manitoba.
2. To obtain data on student achievement that will assist in curriculum and program improvement, both at the provincial and local level.
3. To assist school divisions in both student and system evaluation.
4. To help teachers improve their student evaluation skills.

Reporting of the Science Assessment

The Science Assessment was based on the objectives of the Manitoba Science curriculum combined with the input of teachers attending meetings held throughout the province. The test data results provide an indication of student performance on a number of test areas in grades 5, 8, and 11. The results are reported on a provincial basis only, and no individual students, schools, or school divisions are identified. The Preliminary Report: Test Data contains the detailed information on test items and test areas.

Based on the interpretations of results by experienced science teachers and other educators, and on survey data from teachers of science at grades 5, 8, and 11, conclusions and recommendations were formulated. These, as well as a description of the program, are provided in the Final Report.

The two-part reporting format was designed to speed the presentation of information to teachers and to involve additional educators in the formal interpretation of results. The Preliminary Report was distributed to all Manitoba schools in February, 1981, and interpretation meetings were held in March in various locations throughout Manitoba. With the added input of the interpretations presented at these meetings, conclusions and recommendations were derived for the Final Report. The Final Report does not provide a complete picture of the program, and the reader is referred to the Preliminary Report and to copies of the actual tests for a full explication of the assessment and detailed data on the test questions.

For further information on the Science Assessment contact:

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ACKNOWLEDGEMENTS

An assessment of this scope would not be possible without the collaboration and support of the many people involved in test and report production. In particular, cooperation of over 36,000 students at the three grade levels who wrote the tests, and that of teachers and principals who assisted in the administration is greatly appreciated. We hope the results of this testing will assist educators in improving their understanding of the challenge of teaching science.

It is impossible to name all who contributed to the program but certain persons and groups deserve special mention:

- The Joint Committee on Evaluation which provided guidance throughout the program.
- The Science Technical Advisory Committee which advised on test production, analysis, and final reporting.
- The teachers and others who participated in the review of objectives and the interpretation and review of results.
- The schools, teachers, and students that were involved in the pilot testing.
- The divisions and schools that released their teachers to assist in the program.
- The staff of the Measurement and Evaluation Branch and other Branches of the Department of Education who provided necessary support throughout the program.
- Drs. Hal Grunau, Sylvia Leith, Tom Meadows, Ken Slentz and Harvey Williams, Faculty of Education, University of Manitoba, who gave professional assistance to all aspects of the program and who, with assistance from the Science Technical Advisory Committee, drafted this final report.
- Dr. Joy Thompson who was responsible for the final draft of this report.
- Linda Johnson and Dorothy Tachinski who typed and retyped this report.

A WORD OF CAUTION ABOUT THE ASSESSMENT PROGRAMS

All measurements of human performances are estimates of actual skills. When assessed, these skills are approximations of what actually occurs within the learner. Every effort has been made to minimize errors of assessment but they can occur in a number of ways: the specification of skills and objectives, the selection of materials and production of test questions, the weighting of questions, the interpretation of questions by students, the presentation of results, and the interpretation of these results. Furthermore, the intent of the assessments is to obtain estimates of the performance of Manitoba students in general. Individual student diagnosis or grading on the basis of the tests should be attempted only in conjunction with other tests and assessments.

In the interpretation of results it should be noted that it is not possible to attribute performance strengths and weaknesses to specific aspects of instruction, such as programming or teaching. In addition, a variety of societal factors must be considered when interpreting the results. The interpretations presented in this report provide an initial set of criteria on the performance of Manitoba students.

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OVERVIEW AND HIGHLIGHTS
OF THE SCIENCE ASSESSMENT

The 1980-81 school year marked the third year of the Manitoba provincial assessment program as it is presently designed. In November of 1980 most students in grades 5, 8, and 11 participated in the Science Assessment Program. The test papers for a sample of approximately 10 percent of all students at these grade levels were submitted to the Department of Education; in total 4005 student papers were received for the provincial sample. The overall program followed procedures similar to those of the Reading Assessment Program of the previous year.

The science tests were designed to assess knowledge, understanding, and skills to provide an indication of student performance for a number of curricular areas of science. The tests were not designed for the assessment of specific courses. The assessment should provide information for curriculum development both at the provincial and local levels, for teachers and other educators to assist in the review of their own programs, and to the public at large.

NATURE OF THE ASSESSMENT

The Manitoba science program seeks to educate the student in science by giving attention to a broad range of factors which go well beyond knowledge of science content. The goal areas selected for the science assessment were:

1. Knowledge and comprehension of important generalizations, facts, terms, principles, and concepts of science.
2. Application of scientific knowledge and principles to new situations or to practical problems.
3. Higher cognitive level thinking including the ability to analyze and evaluate science data and information, to identify the relationship of parts within the whole situation, and to evaluate the appropriateness of the evidence presented in a science content setting.

(These three goals encompass understanding of science content. At each grade level, the first two goals were assessed separately for earth and space science, physical science, and life science. At the grade eleven level enough items were included to allow physical science results to be reported for physics and chemistry.)

4. Processes of science knowledge and skill, both in basic processes such as observing and classifying and in integrated processes such as hypothesizing and experimenting.

(At the grade five and eight levels enough items were included to allow results to be reported separately for basic and integrated processes.)

5. Nature of science including those ways of thinking that are essential to a scientific approach.
6. Safety knowledge, procedures and precautions in the use of materials and equipment. At the grade eleven level knowledge of laboratory technique was assessed.

7. Attitudes to, and interest in, science, particularly interest in science activities.

These goal areas are not mutually exclusive, for example higher cognitive level thinking arising in the context of a science content area may include one or more aspects of such integrated processes as hypothesizing or interpreting data.

ASSESSMENT PROCEDURES

The assessment program began with the identification of grade levels and topics. Teachers and science specialists developed the actual test objectives and questions. Over 150 teachers and others throughout Manitoba participated in discussions regarding the objectives. The actual tests were produced in sufficient quantities for teachers to opt for testing entire classes although the provincial sample was approximately 10 percent of the students. On November 19 an estimated 36,600 students in Manitoba schools, in grades five, eight, and eleven, wrote the tests.

The results of the provincial sample were analyzed and reported to schools in the Preliminary Report: Test Data. Since these data were not based on any previous assessments, interpretations of the results were determined with the assistance of approximately 150 teachers, other educators, and trustees. This was done through a series of meetings held in locations throughout Manitoba in March of 1981.

This Final Report contains a summary of the results and the interpretations based on these results.

MAJOR FINDINGS OF THE STUDENT ASSESSMENT

Grade Five

Grade five student performance on knowledge and comprehension of science content was more than satisfactory, while performance on application of science content showed some weaknesses in earth and space science. Student performance was more than satisfactory on integrated processes and on the higher cognitive level goal. Performance was satisfactory on basic processes, nature of science, and safety. Overall grade five students' attitudes to, and interests in, science were very positive.

Grade Eight

Grade eight student performance was satisfactory on knowledge and comprehension of science content, and on basic and integrated processes. Performance was less than satisfactory on the higher cognitive level goal, and on nature of science, and safety. Student performance on application of science was mixed, showing some weaknesses in earth and space and in physical science. Overall grade eight students' attitudes and interests toward science were marginally positive.

Grade Eleven

Grade eleven student performance was more than satisfactory on nature of science and on application of science content. Performance was satisfactory on the higher cognitive level skills and on processes of science. Student performance on safety and laboratory technique was less than satisfactory, as it was on knowledge and comprehension of science content. Overall grade eleven students' attitudes to, and interests in, science were marginally positive.

PROFILE OF MANITOBA SCIENCE TEACHERS

These profiles are based on information provided by those responding to teacher questionnaires administered in conjunction with the student assessment.

Grade Five

Grade five science teachers often teach grade four or grade six science as well as grade five. In the past they have often taught grades from three to eight. They teach science for an average of 2.5 hours per five day week and are most likely to have twenty or less students in their classroom. These teachers usually require no preparation or clean-up assistance and they maintain and account for their own equipment and materials.

The grade five teacher usually relies upon teacher made tests and student attitude and work habits for student evaluation. The tasks most often assigned to science students are working experiments, discussing experiments, listening to lectures, applying information to problem solving situations, interpreting and explaining experimental results, describing observations, copying notes, reading from textbooks, and working with basic processes.

Grade five teachers usually follow the Department of Education curriculum guide. They prefer, are the most familiar with, and most often use the S.T.E.M. curriculum materials. They are generally comfortable teaching science. They believe that the quality of science instruction would go up if they had more time for preparation and marking, had more science books in the library, were provided with a wider selection of books, had fewer subjects to teach, and had smaller classes.

Grade five teachers rate science as equal in importance to other subjects. Most have had one science education or methods course. Their university science courses are most likely to be in biology or earth science. The most relevant in-service topics suggested are techniques of teaching science, how to develop curriculum materials, preparation of science materials, laboratory safety and discussion of problems of science teaching.

The grade five teachers believe that the most important purposes of elementary science programs are to develop attitudes such as curiosity, objectivity and accuracy, develop skills in science processes, develop positive attitudes toward the physical environment, and develop an interest in science.

Grade Eight

Most grade eight teachers have from 25 to 28 students in their classrooms. Grade eight science teachers are likely to be teaching grade seven and/or nine as well. Few have taught in high school but many have taught below grade seven. Forty-seven percent teach other subjects as well as science. As a group, grade eight science teachers receive no preparation or clean-up assistance. They spend an average of three to four hours per week preparing lessons and marking papers for science classes. Most grade eight teachers assign homework three to four times per cycle. Grade eight teachers most often evaluate their students on teacher made objective tests, laboratory write-ups, projects, attitude, and work habits.

The activities or tasks most often assigned to students by grade eight teachers are listening to lectures, describing and reporting on observations, interpreting or explaining the results of an experiment, making guesses about the results of an experiment, applying information to new problem situations and copying notes from the chalkboard. Most feel that they have enough or almost enough time to achieve their teaching objectives.

Grade eight teachers rate their science material and equipment as fair to good in both quantity and quality. Most are teaching the new curriculum or a mixture of the new and old. They find the "Focus on Science Series" and the "Exploring Science Series" to be the most useful curriculum materials. Most grade eight science teachers spend approximately equal portions of their teaching time on each of the six content areas of the grade eight curriculum. Generally they feel that the new curriculum requires more work.

Given a choice, most grade eight science teachers prefer to teach grades seven to nine. They are comfortable teaching science and believe science to be at least equal in importance when compared to other subjects. Grade eight teachers have from one to three university courses in several areas of science but lack astronomy courses. With regard to in-service teacher education, grade eight science teachers recommend the following topics: techniques of teaching science, discussion of problems of science teaching, how to develop curriculum materials, survey of available curriculum materials, testing and evaluation in science, and laboratory safety.

Grade Eleven

Grade eleven science teachers often teach a variety of science courses ranging from grade nine science to 200 and 300 chemistry, physics and biology. The grade eleven science teacher is generally a full time science teacher; on occasion he/she may teach another subject. Class size for grade eleven science teachers averages 25 to 28 students.

Grade eleven science teachers spend from four to six hours per week preparing and marking science papers. These teachers usually mark all laboratory write-ups and evaluate students most often on teacher made objective tests, laboratory write-ups, examinations, and notebooks. These teachers assign an average of three homework assignments per week.

Grade eleven science teachers engage their students in a wide range of activities, but the activity which occurs most often is listening to lectures. Most grade eleven teachers teach in a semester system and most feel they have enough time or nearly enough time to satisfy their objectives. These teachers rate both the quality and quantity of their laboratory equipment as good.

Grade eleven teachers generally rate the reading material available to their students as satisfactory. They found the Department of Education Curriculum Guides useful. They prefer to teach senior high; nearly all are comfortable teaching science. These teachers rate science as being of equal importance or more important than other subjects, and they believe that the major purpose of 100 level science programs is to prepare students for 200 level science courses.

Most grade eleven science teachers have a major concentration in science education. Their content background is nearly equally distributed between chemistry, biology, and physics. They believe that in-service training should focus upon laboratory safety, techniques of teaching science, discussion of problems of science teaching, survey of available curriculum materials, and testing and evaluation in science.

RECOMMENDATIONS

General recommendations arising from a synthesis of the student assessment results and teacher survey data are presented in Chapter VII. These recommendations are summarized below.

1. That all teachers of science should enhance their classroom activities with a variety of process-centered student activities. The basic processes, as well as many of the integrated ones, can and should be an integral part of most activities in science.
2. That every teacher of science should make a deliberate attempt to relate the logical thinking processes involved in science to the students' every day activities.
3. That specific safety classes be conducted in all areas of science at all grade levels to teach students appropriate techniques and procedures. These procedures should be practised as a part of the normal classroom routine.
4. That all educators make sure that their efforts to do as much as possible to allow all students to achieve to their potential regardless of the subject matter. All educators should be aware of a possible sexist bias in curriculum, in textual materials, in classroom management practices, and in the instructors own attitudes, and should develop teaching strategies to combat it.
5. That teachers be assisted in becoming familiarized with alternative teaching strategies in K-6 and 7-9 science, in particular with ways and means of shifting from teacher-centered to more student-centered classrooms.
6. That schools address the need to purchase sufficient quantities of textual and other reading materials to allow teachers to adequately teach their science programs. This need is most acute at the elementary level.
7. That assistance be given teachers by school divisions to further the implementation of the new science curriculum.
8. That teachers examine their own programs in the light of identified strengths and specific areas of concern, regarding student performance.

CHAPTER 1

THE SCIENCE ASSESSMENT PROGRAM

The Science Assessment was intended to provide a broad base of accurate and current information on the performance of students in Manitoba. The science program for Manitoba schools is designed to educate the student in science over a wide range of science goals and objectives that go well beyond knowledge of science content. The tests were not developed to assess specific courses but to survey student performance on the kinds of understanding, skills, and attitudes that are included in the Manitoba science curriculum and are being emphasized by Manitoba teachers.

Measurable science objectives and test questions were developed, and the student results were analyzed relative to these objectives. The results provide an indication of student performance for a number of curricular areas in each of grades five, eight, and eleven. All results are reported on a provincial basis only, with no identification of any individual students, schools, or school divisions. A survey of science teachers was conducted in conjunction with the assessment to provide teacher information that would complement the student achievement data.

Following the selection of science as an assessment area, a Science Technical Advisory Committee (Science TAC) and a Science Contract Team were established to assist in the actual production of the tests and review of the results. The Science TAC consisted of three teachers of science from each of the grade levels involved and one person from the Measurement and Evaluation Branch. Department of Education science curriculum staff and the Science Contract Team acted as consultants to the committee.

The Science TAC was responsible for overseeing all test development and for overseeing production of reports. The Science TAC members recommended objectives to be assessed and types of test items to be used. They reviewed in detail all material produced by the Science Contract Team as well as the pilot test results. They reviewed the final assessment results and suggested implications and recommendations for teachers and curriculum developers.

The Science Contract Team, consisting of the science education staff of the Department of Curriculum: Mathematics and Natural Sciences, University of Manitoba, gave professional assistance to all aspects of the program. They produced the objectives and test items for review by the Science TAC. They assisted at regional meetings for interpretation of results, and produced the first draft of this final report.

Both the Science TAC and the Contract Team received direction from the Measurement and Evaluation Branch.

STEPS IN THE ASSESSMENT PROGRAM

Following establishment of the Science TAC and Science Contract Team, the steps involved in the Science Assessment Program were:

Step One: Identification of Goals and Objectives

Development of materials for the science assessment began with the identification of goals for science programs from kindergarten through grade ten. The goals and philosophies of the Manitoba Department of Education Curriculum Guides assisted the Science Contract Team and the Science Technical Advisory Committee in making the decision for determining what skills, knowledge, and attitudes were to be assessed.

Once the overall goals for the science assessment were established, the Science Contract Team produced an extensive list of specific measurable objectives based on those goals that were appropriate to the grade levels being tested. For the grade five test, objectives appropriate at the kindergarten through grade four level were developed. Similarly, objectives up to and including grade seven, and up to and including grade ten were developed for the grade eight and grade eleven test respectively. These objectives were based largely on curriculum guides in use during the 1979-80 school year. The majority of grade eleven students would have completed grade ten science, this being the last year of a science program common to all students in Manitoba schools.

Step Two: Verification and Selection of Objectives

Science teacher representatives from each School Division or District rated the importance of both the assessment goals and the specific objectives. This occurred at a series of regional meetings held in locations throughout Manitoba. Teachers at these meetings reviewed, supplemented, and rated the science objectives; suggested methods of assessment; and indicated additional information on teachers that would be useful to collect.

Data from the regional meetings were compiled to assist in the determination of the final list of specific objectives for which test items were subsequently written.

Step Three: Production of Tests

The Science TAC recommended a format for the tests based on the input of science teachers at the regional meetings. Items were written by the Contract Team according to this format using the objectives identified. The team was also guided by the need to write items at various cognitive levels, as well as the need to ensure that the readability level was appropriate. Multiple choice items were used throughout with the exception of the attitude items which were Likert-type items with five response choices from "strongly agree" to "strongly disagree".

Pilot test items were reviewed twice by the Science TAC. Initial modifications, additions, and deletions were based on readability, accuracy of science content, general suitability for the grade levels, and the technical quality of the items. Item analyses of pilot test results formed the basis for a further review. Inappropriate items were deleted or modified, and the tests were shortened. Comments from teachers at the pilot schools were also considered in this review. The Science Contract Team revised the tests and constructed an administration manual for each level.

The test instruments for science were developed for the three grade levels in both the French and English languages. Production of two versions of an assessment instrument in different languages is a complex procedure involving more than mere translation. The Science TAC membership included French language science teachers and the Bureau de l'Education Francaise science consultants. They assisted in test development, and made recommendations on test construction, based on input from a meeting of French language teachers of science. A Manitoba consulting company (CERECO, INC.) was contracted to assist in the technical aspects of constructing tests in French.

Final tests and administration manuals were printed and distributed to schools by the Department of Education.

Step Four: Provincial Administration of Tests

Approximately ten percent of all students in grades five, eight and eleven in Manitoba's public schools were designated in advance for the provincial sample. Students eligible for the sample were all those enrolled in public schools in grades five, eight, and eleven, regardless of whether or not they were taking a science course at the time of the test. In late August, 1980, the Research Branch of the Department of Education requested student enrollment numbers in those grades. Teachers were asked to indicate whether they wished to test their whole class or test only the provincial sample, and whether they wished French language or English language versions of the science tests.

The tests were administered on the morning of Wednesday, November 19, 1980. The grade eight and eleven students placed their answers directly on a standard answer sheet which was machine scanned. The grade five students answered the test items in the test booklet. These responses were transferred to standard answer sheets by Department of Education personnel and were machine scanned.

Schools were requested to return those tests designated by the Department for the provincial sample. The actual sample of student tests analyzed was approximately 89 percent of the designated sample. The sample loss was due primarily to student absence and transfer, as indicated on the returned sample lists. Table 1 indicates the provincial sample of tests at each grade level.

Table 1

PROVINCIAL SAMPLE OF TESTS

Grade	Number of Students Eligible			Tests Scored (Sample)			
	English Tests	French Tests	Total	Females	Males	Total	Percentage
5	15,150	450	15,600	673	754	1427	9.15
8	15,030	220	15,250	680	716	1396	9.15
11	14,085	55	14,140	598	584	1182	8.36

Step Five: Reporting of Test Data

A detailed presentation of the student data collected by the Science Assessment Program 1980 can be found in the Preliminary Report. The data was presented in tabular form and was accompanied by a minimum of discussion as the report was designed only to provide basic information on student data for use by classroom teachers. This report was distributed to all schools.

Results were reported on a provincial basis only. Thus there was only one set of results combined for the English and French language science students in the provincial sample.

Step Six: Interpretation of Results

The assessment results are estimates of levels of performance of students, but these levels must be evaluated as to their quality or adequacy. At this point no adequate performance standards are available from past years. Also, criterion performance levels based on general rules--e.g., "50% correct is necessary to pass an objective"--are arbitrary and are not dependent on the objective in question. Thus, performance levels were adjudicated in a different manner.

Seven regional meetings of teachers were held in March 1981 to interpret and analyze the results and to suggest implications and recommendations for educators. The initial meeting involved an invited panel of experienced science educators and trustees. Then science teacher representatives were invited from each School Division or District. The Science TAC and the Science Contract Team helped determine procedures for these meetings and assisted at these meetings. Since the Science Assessment tests were designed to assess a number of separate goals, performance expectations and interpretations were made for each of the test items and science goals. Working in grade groups, participants at the meetings estimated two levels of performance, "adequate" and "desirable", for each test item (except attitude items) according to the following definitions:

> "Adequate" performance - the minimum percentage of students in the province which you feel must complete an item correctly in order for performance to be considered satisfactory. Performance below the adequate level would, in your opinion, be considered indicative of a weakness.
>
> "Desirable" performance - the percentage of students in the province which you would like to see complete an item correctly-- a goal toward which to strive. Performance at or above the desired level would, in your opinion, be considered as indicative of a strength.

After estimating these two levels of performance for each item, each grade group then made interpretation ratings regarding the obtained student results. Using the previously established adequate and desirable levels of performance as a guide for making judgements, they rated the student performance (obtained percentage correct) on each item according to a five-point scale as follows:

Strength
Very Satisfactory
Satisfactory
Marginally Satisfactory
Weakness

The group then examined interpretation ratings of all items for a particular goal, and made an interpretation rating for overall performance on that goal. Participants summarized and interpreted the identified strengths and weaknesses for each goal and made comments regarding performance on the goal. The final task in interpreting the results was the generation of educationally relevant, specific recommendations.

The procedure for judging student performance involves making estimates and ratings for each test item. Therefore it is likely that some items that have lower percentage correct scores may receive a higher interpretation rating than other items that have higher percentage correct scores. Because of varying levels of difficulty of items it was quite possible to have an item with less than 50 percent correct being rated "very satisfactoy" whereas for another item a 75 percent correct response may be considered "marginally satisfactory".

Interpretation ratings made for overall performance on goal involved a separate, global judgement by the same group of teachers who made the item-by-item ratings.

Interpretation ratings were not made for the attitude items: these results should be considered as responses to an opinion survey only. The data was combined into a three-point scale of "agree", "undecided", and "disagree".

The median interpretation ratings for items and for goals, and the recommendations resulting from regional meetings, have been used as a basis for this report. Interpretive information and conclusions are presented together with more comprehensive findings and recommendations. Results of the teacher survey are also presented.

NATURE OF THE ASSESSMENT

The tests were designed to assess science knowledge, understanding, and skills in order to provide an indication of student performance for a number of curricular areas of science. The goals selected for the science assessment were:

1. Knowledge and comprehension of important generalizations, facts, terms, principles, and concepts of science.
2. Application of scientific knowledge and principles to new situations or to practical problems.
3. Higher cognitive level thinking including the ability to analyze and evaluate science data and information, to identify the relationship of parts within the whole situation, and to evaluate the appropriateness of the evidence presented in a science content setting.

These three goals encompass understanding of science content. At each grade level, the first two goals were assessed separately for earth and space science, physical science, and life science. At the grade eleven level enough items were included to allow physical science results to be reported for physics and chemistry.

4. Processes of science knowledge and skill, both in basic processes such as observing and classifying and in integrated processes such as hypothesizing and experimenting.

At the grade five and eight levels enough items were included to allow results to be reported separately for basic and integrated processes.

5. Nature of science including those ways of thinking that are essential to a scientific approach.
6. Safety knowledge, procedures and precautions in the use of materials and equipment. At the grade eleven level knowledge of laboratory technique was also assessed.
7. Attitudes to, and interest in, science, particularly interest in science activities.

These goals are not mutually exclusive, for example higher cognitive level thinking arising in the context of a science content area may include aspects of such integrated processes as hypothesizing or interpreting data.

The following summary of science processes is adapted from K - 6 Science, Manitoba Department of Education, 1979, pp. 14-15; and from 7 - 9 Science, Manitoba Department of Education, 1979, pp. 11-12.

TYPES OF BASIC PROCESSES

Observing - using our five senses, or senses extended by instruments, to describe objects and events.

Classifying - sorting or ordering objects, ideas, or events, according to their similarities and differences.

Measuring and Use of Numbers - making more precise statements about data by means of standard and non-standard units and other quantifying procedures and conventions, including proper use of instruments.

Communicating - using appropriate means to communicate scientific information, including models, maps, graphs, data tables, in addition to oral and written methods.

Inferring - suggesting more about a set of conditions than is observed; i.e. a guess based upon experience plus observation.

Predicting - forecasting made about future events based upon data already obtained. Includes interpolation and extrapolation.

Space/Time Relations - naming and describing objects using their spatial or time characteristics or relationships. i.e. describing or identifying such things as "up," "triangle," "circumference," "litres per second," and the like.

TYPES OF INTEGRATED PROCESSES

Defining Operationally - defining objects or events in a way which can be tested or observed; i.e. by how they operate.

Experimenting - testing to see if a cause and effect relationship exists between two variables (manipulated and dependent)

Hypothesizing - making a statement about the expected relationship between the variables in an experiment

Controlling Variables - identifying, manipulating, isolating, and otherwise controlling the variables likely to effect the proper testing of a cause and effect relationship.

Interpreting Data - using and selecting data to draw inferences, determine relationships, identify trends, or state conclusions.

Use of Models - formulating and/or using models to simplify and make more concrete mental ideas or abstract relationships.

Theorizing - suggesting a generalized explanation that is believed to be true because of evidence based upon partial data and the lack of evidence which could disprove the explanation.

Average provincial scores, expressed as an average percent correct, were calculated for each of the goals for each grade level. These are summarized in Table 2 below.

Table 2

SUMMARY OF STUDENT PERFORMANCE ON SCIENCE GOALS

GOAL	GRADE 5				GRADE 8				GRADE 11			
	# Items	Percent Correct F	M	Total	# Items	Percent Correct F	M	Total	# Items	Percent Correct F	M	Total
Knowledge and Comprehension												
Earth and Space	7	55.4	58.1	56.9	16	57.9	62.1	60.1	16	35.0	43.6	39.3
Physical	10	41.2	46.3	43.9	21	45.9	51.9	49.0	12 P 12 C	49.4 42.4	57.5 42.4	53.4 42.4
Life	7	72.1	71.3	71.6	13	52.7	53.5	53.1	13	41.2	45.5	43.4
Application												
Earth and Space	5	44.2	47.7	46.0	5	38.0	49.8	44.0	4	64.6	74.8	69.5
Physical	7	38.2	43.2	40.8	11	42.8	48.6	45.7	12 P 16 C	48.3 49.6	54.3 53.4	51.3 51.6
Life	6	54.8	55.3	55.2	4	80.0	77.8	78.8	9	57.9	54.7	56.3
Higher Cognitive Levels	7	35.0	35.0	35.0	4	31.3	35.3	33.3	7	41.3	46.7	44.0
Processes	5 B 4 I	66.8 65.5	63.8 66.8	65.2 66.0	12 B 9 I	61.3 50.8	57.3 50.2	59.3 50.4	5	49.6	52.4	51.0
Safety	2	60.5	62.5	61.5	4	50.5	53.5	52.0	5	54.0	56.0	55.0
Nature of Science	4	54.0	52.0	53.0	3	65.0	57.0	60.7	4	76.6	74.0	75.2
Lab Technique									3	46.3	48.0	47.0

F - Female
M - Male

B - Basic Processes
I - Integrated Processes

P - Physics
C - Chemistry

CHAPTER II

GRADE FIVE RESULTS

This chapter attempts to analyze and discuss the grade five provincial results and interpretation ratings for each goal or general objective. Comparisons with grade eight and eleven results are presented in Chapter V and teacher survey results are in Chapter VI. Recommendations arising from the Science Assessment are presented in Chapter VII.

The Science Assessment Program 1980 collected and analyzed science test results for a 10 percent sample of all students in grades five, eight, and eleven. The test data in the Preliminary Report give, for each test item, the number of students who selected each option. They also give the percentage of students who achieved each possible score or mark on the goal or general objective; these percentages are reported for females, males, and total sample.

The distribution of items for the grade five test was as follows:

	Items
earth and space science--knowledge and comprehension	7
--application	5
physical science--knowledge and comprehension	10
--application	7
life science--knowledge and comprehension	7
--application	6
higher cognitive level--all three content areas	7
basic processes	5
integrated processes	4
safety	2
nature of science	4
attitude	6

ACHIEVEMENT RESULTS

Tables in this chapter present the average percent correct and the median interpretation ratings for each item and goal. Lower "percent correct" scores may obtain a higher interpretation "rating" depending on the difficulty of the item. The "overall rating for goal" is not an average of the ratings listed for each item. Instead it is the median of a separate, global judgement of student performance on the goal made by the same teachers who made the item-by-item ratings.

Earth and Space Science--Knowledge and Comprehension

Seven items on the grade five test were in the knowledge and comprehension area of earth and space science. These items assessed students' knowledge and understanding of space/time relationships, the sun, evaporation, weathering and erosion, and students' ability to state the temperature in Celsius of melting ice.

Descriptions of items, average percent of students responding correctly to each item, and the median interpretation ratings of teachers are presented in Table 3 below. The average percentage results for males and females are also given. See page 9 for a discussion of the interpretation rating procedure used.

Table 3

EARTH AND SPACE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
22	Position of objects	93	strength
24	Comparing objects as to size	93	strength
26	Sun is a star	65	satisfactory
34	Particle model of evaporation	52	very satisfactory
25	Shape of 3-D object-cylindrical	48	very satisfactory
30	Reading temperature of ice and water	33	marginally satisfactory
36	Distinction between erosion and weathering	13	weak
	AVERAGE PERCENT - Total	56.9	OVERALL RATING FOR GOAL
	Female	55.4	
	Male	58.1	Very Satisfactory

Grade five students scored high on the space/time questions relating to position of objects, and to size comparisons of objects. These concepts are generally taught by the end of grade one. Students scored considerably lower on the item in which they had to name the 3-dimensional object in a picture as cylindrical. Two thirds of the children indicated that the sun is a star (not a moon, satellite, plant or solar system).

More difficulty occurred with the question relating to the particle model of evaporation where one third of the children selected the response which had all the molecules in a gaseous state. Few (one third) were able to pick the correct temperature for a dish of ice and water mixture sitting in the sun. This was a difficult question for beginning grade fives, especially with the added component of the sun in the picture. As well as this, students may have had difficulty with temperature in degrees Celsius.

The erosion-weathering question was answered correctly by only 13%. Many children picked the incorrect response "erosion" when asked for "the breaking down of solid rocks is...". The distinction between weathering and erosion is an important one but is probably not emphasized by many teachers.

The interpretation panel rated performance on the knowledge and comprehension goal of earth and space science as "very satisfactory". They did, however, expect more students to know that the sun is a star and recognized deficiencies in the earth science area.

Earth and Space Science--Application Level

There were five application level questions in the earth and space science areas for grade five. These items were concerned with seriation of objects as to size, applying knowledge of the Celsius scale to a noon temperature in Manitoba, applying the concept of air occupying space and two earth science questions on stream erosion and the sorting of materials in water.

Table 4 gives the average provincial percent correct together with the median interpretation ratings of teachers.

Table 4

EARTH AND SPACE SCIENCE--APPLICATION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
23	Seriation of objects as to height	80	very satisfactory
28	Determining noon temperature in Manitoba	45	weak
33	Applying concept that air occupies space	38	marginally satisfactory
35	Determining area of greatest stream erosion	23	weak
37	Predicting sorting pattern of sand and pebbles	19	weak
	AVERAGE PERCENT - Total - Female- Male -	40.8 38.2 43.2	OVERALL RATING FOR GOAL Weak to Marginal

The seriation question was completed successfully by most children. Seriation is a skill usually mastered as a pre-requisite to reading. In this item the students had to rank order five triangles of different heights, and select the correct response from a list. They were not able to physically move the objects as primary age children would. This could partially account for the less than perfect response.

In all the other items the students achieved less than 50% correct. Only 45% were able to select correctly the month where the typical noon temperature is 25°C. Many selected March rather than July. This would suggest that they are confusing the Fahrenheit with the Celsius scale.

The question on the fact that space occupied by air in the upturned glass kept the water out, was difficult for many children. This activity was probably done in the grade four water unit, but the children had difficulty in selecting the best response.

The earth science questions had less than a quarter correct responses. In this section the questions were indeed difficult, especially the stream erosion item. Students would be helped if they had actually observed the differential erosion ability of a stream in the school yard or in a stream table in the classroom. The question on the pebble sorting in the jar presented another difficulty. The statement "What will they see happen?" may have confused the children as to the time implied--now or later?

The interpretation rating of performance on this goal was "weak to marginal".

Table 5

PHYSICAL SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
29	Types of energy	72	very satisfactory
41	Kind of energy produced by an electrical appliance.	57	very satisfactory
45	Recognizing a "push" as a force	53	strength
39	Picking the circuit which will light a bulb	48	marginally satisfactory
38	Knowing which appliance uses the most electricity.	47	satisfactory
54	Relating shape to quantity of material.	44	satisfactory
47	Identify luminous objects	37	satisfactory
48	Recognizing that air conducts sound.	34	weak
40	Recognizing the source of energy for a flashlight.	33	weak
53	Knowing that gases fill their container.	13	weak
	AVERAGE PERCENT	Total - 43.9 Female - 41.2 Male - 46.3	OVERALL RATING FOR GOAL Satisfactory

Physical Science--Knowledge and Comprehension

There were ten test items in physical science which were considered to be at the cognitive level of knowledge and comprehension. These items were primarily concerned with the facts and terminology associated with force, energy, and state of matter.

Table 5 gives the average provincial percent correct together with the median interpretation ratings of teachers.

The facts and principles of physical science known best to grade five students relate to types of energy, energy transformation (electrical energy transformation to other types of energy), and energy consumption (which type of appliance uses the most electricity in a given unit of time). Questions whose success ranged from 47 percent to 57 percent referred to facts associated with electrical circuitry, picking out the appliance properly matched with the main kind of energy it produced and scientific relationships (a push is a force). Only one third recognized the source of energy for a flashlight.

The knowledge and comprehension questions which were answered correctly by few grade five students in physical science are almost wholly associated with cause and effect relationships. Only 13 percent of the grade five students knew that a gas always fills its container, 34 percent selected a liquid for this question and 25 percent thought it could be either a liquid or a gas. Of interest is the result that only 44 percent were able to respond correctly to the conservation task by knowing that material is not altered by a change in shape.

Overall performance on this goal was "satisfactory".

Physical Science--Application

There were seven items on the assessment test which related to physical science at the cognitive level of application. These items were primarily concerned with applying knowledge in the areas of sound, light, magnetic polarity, and solutions, with one item on support strength of a physical structure (the straw bridge item).

Table 6 gives the average provincial percent correct together with the median interpretation ratings of teachers.

Grade five students responded best on the items which were supported by pictorial diagrams (strings of varying length between two boards, sketches of bridges made from soda straws, and a sketch of a telephone made from paper cups and string).

Items in this section which caused the most difficulty involved magnetism, and the proper method for recovering salt from a solution.

Overall the interpretation rating for this goal was "satisfactory".

Table 6

PHYSICAL SCIENCE-APPLICATION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
49	Relating frequency of sound to length of string.	58	satisfactory
51	Distinguishing between the speed of light and the speed of sound.	55	satisfactory
50	Realization that sound needs a medium to travel through.	52	very satisfactory
44	Relating physical structure to support strength.	52	strength
46	Recognizing the effect of illumination.	47	satisfactory
43	Deducing the polarity of magnets from attraction - repulsion information.	36	satisfactory
52	Method of recovering salt from a solution.	24	weak
	AVERAGE PERCENT Total -	46.1	OVERALL RATING FOR GOAL
	Female -	44.9	Satisfactory
	Male	47.3	

Life Science--Knowledge and Comprehension

Life science at the grade five level related to knowledge of vertebrate animals and their life habits, reproduction by plants and animals, and development of animals.

Table 7 gives the average provincial percent correct together with the median interpretation ratings of teachers.

Performance ranged from 52 percent to 92 percent, and achievement on all but one item at this level was rated as "satisfactory" or "very satisfactory". Most children knew that babies come from mothers and that ducks and geese migrate. Fewer knew that caterpillars become butterflies and that frogs lay their eggs in water; 52 percent were knowledgeable about mammalian characteristics.

Knowledge of animal reproduction and development was judged to be "satisfactory" to "very satisfactory", while knowledge of plant reproduction was only "marginally satisfactory"--only 56 percent of the students knew that seeds were produced from flowers.

Overall student performance on this goal was noted as "very satisfactory".

Table 7

LIFE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
56	Babies come from mother's bodies	92	very satisfactory
65	Ducks and geese migrate long distances	81	very satisfactory
55	Deer and beaver are plant eaters	77	strength
58	Caterpillars become butterflies	73	very satisfactory
66	Frogs lay their eggs in water	71	very satisfactory
60	Seeds are produced by flowers	56	marginally satisfactory
62	Whales and humans produce living young and are nursed	52	satisfactory
	AVERAGE PERCENT Total -	71.6	OVERALL RATING FOR GOAL
	Female -	72.1	
	Male -	71.3	very satisfactory

Life Science--Application

Application level items required associating animals with their natural habitat, classifying skills, inferring about camouflage, understanding the importance of light to plants, and environmental problems.

Table 8 gives the average provincial percent correct together with the median interpretation ratings of teachers.

At the application level in life science, grade five performance on most items was noted as "strength" or "satisfactory" but two items that required more abstract reasoning were rated "weak". From a picture showing a group of animals and a marsh, grade five children were able to identify those animals that lived in a marsh. Many of the students were able to classify a picture of a leaf with a similar group in a task which required no prior knowledge of leaves or leaf structure. Weakness was identified in the children's ability to apply the principle of camouflage (43% correct) and to predict that plants would die without sunlight (41%).

Application of concepts relating to environment, habitat and adaptation was judged to be "satisfactory" to "very satisfactory". However, weakness was identified in the ability to apply concepts to hypothetical situations.

Overall, the interpretation rating of the achievement level of grade five students in the life sciences was "satisfactory".

Table 8

LIFE SCIENCE--APPLICATION: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
61	Identify animals that live in a marsh	89	strength
63	Compare and match leaf types	62	strength
57	Identify mice as animals that live in grasslands	54	satisfactory
64	Apply the concept of camouflage	43	weak
68	Predict a plant will die if kept in darkness	41	weak
70	Identify human body waste as pollution	41	satisfactory
	AVERAGE PERCENT Total	55.2	OVERALL RATING FOR GOAL
	Female	54.8	
	Male	55.3	satisfactory

Higher Cognitive Level--All Three Content Areas

At the higher cognitive level there were seven assessment items. These items generally involved scientific deductions in the areas of photosynthesis, ecology, weather and pressure change.

Grade five students responded to higher cognitive level questions as indicated in Table 9.

All questions at the higher cognitive level for earth science, physical science and life science were combined and labelled "Higher". Items in this section generally required some scientific deduction.

Students generally did better than was expected in this area, given the nature of the test items, and the overall rating of performance on this goal was "very satisfactory".

Table 9

HIGHER COGNITIVE LEVEL: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
69	Relating the growing plant to effects of the sun.	60	very satisfactory
67	Determining what an animal likes to eat.	46	very satisfactory
31	Effect of decreased pressure in a closed system.	38	strength
27	Cause for warm weather in summer.	36	very satisfactory
32	A supposition about condensation.	27	satisfactory
42	Making a derivation from a table of data	23	marginally satisfactory
59	Explaining the result of removing an element from an ecological food chain	15	weak
	AVERAGE PERCENT Total -	35.0	OVERALL RATING FOR GOAL
	Female -	35.0	
	Male -	35.0	very satisfactory

Basic Processes

Two levels of science processes were examined - basic processes and integrated processes. Description of process items, average percent of students responding correctly to each item, and the median ratings of teachers are presented in Table 10. For an outline of basic processes see page

Most students demonstrated they could read a thermometer, name a magnifying glass as an extension of sight, and observe without inferring when provided with a cue. Linear measurement, with rounding to the nearest centimetre, was correctly handled by slightly more than half of the students. On this item, an analysis of student responses showed that a significant number of pupils chose the alternative which demonstrated rounding to the nearest millimetre. This is perhaps a more sophisticated answer for the given diagram and types of scale division presented.

When observation items were presented along with inferential statements, the precise use of the term "observing" was shown to be lacking, with only 34 percent of the pupils responding correctly.

The interpretion rating of all items except one was "satisfactory" or better, with item 20 (observing versus inferring) being rated "weak". Overall rating of student performance on basic processes was "satisfactory".

Table 10

BASIC PROCESSES: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
13	Observation vs inference: burning of a match	79	strength
19	Measurement: reading a thermometer	79	very satisfactory
16	Observation: sight extended by a magnifying glass	75	satisfactory
17	Linear Measurement: rounding to nearest centimetre	59	satisfactory
20	Observing vs Inferring - shown a girl measuring for a recipe	34	weak
	AVERAGE PERCENT	Total - 65.2 Female - 66.8 Male - 63.8	OVERALL RATING FOR AREA: satisfactory

Integrated Processes

Four items assess student performance on integrated processes (designing experiments, controlling variables, interpreting data). Table 11 gives the average provincial percent correct together with the median interpretation ratings of teachers.

Reading and interpreting a bar graph presented little difficulty to the grade five students. Predicting, in the form of interpolating while using a bar graph, was shown to be somewhat more difficult. The expected difficulty of the controlling of variables item was not shown, with two thirds of the students obtaining the correct answer. Reading and interpreting a line graph was shown to be as difficult as interpolating using a bar graph, with 54 percent obtaining the correct answer. Interpretation ratings of "strength" and "very satisfactory" indicate satisfaction with students ability to work with graphs. The performance of students on the controlling variables item was much above panel expectations, and received a rating of "strength"

Overall student performance on the integrated processes goal was rated as "strength".

Table 11

INTEGRATED PROCESSES: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
14	Communicating: reading and interpreting a bar graph	89	strength
12	Controlling variables: growing of seeds	66	strength
15	Predicting: interpolating using a bar graph	54	very satisfactory
18	Communicating: reading and interpreting a line graph	54	strength
	AVERAGE PERCENT	Total - 66.0 Female - 65.5 Male - 66.8	OVERALL RATING FOR GOAL strength

Safety

Only two items were selected to assess "safety" at the Grade 5 level. The results are presented in Table 12.

The interpretation rating of student results was "satisfactory" for this area although the low percentage correct was noted.

Table 12

SAFETY: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
10	Washing, after using pond water	69	satisfactory
11	Precautions for heating a test tube	55	satisfactory
	AVERAGE PERCENT	Total - 61.5 Female - 60.5 Male - 62.5	OVERALL RATING FOR GOAL satisfactory

The Nature of Science

The four items in this area involved scientific approaches to observations and data and the idea of the non-capricious nature of science.

Table 13 gives the average provincial percent correct and the median interpretation ratings of teachers.

Approximately two thirds of the students correctly answered items calling for the need to suspend judgement until sufficient evidence is presented (item 9), and choosing the best example of "scientific thinking", in particular cause and effect thinking (item 21). Performance on these items was rated "very satisfactory".

Less than half the students correctly answered an item requiring intellectual honesty in reporting of results (item 8). Performance on this item was rated "satisfactory". Students seemed very prone to thinking they had made an experimental error when there was lack of agreement between their results and an answer from a text.

Results on a final item (item 7) dealing with the element of superstition ("luck") in science was interpreted as "weak". Student results were almost equally divided between the answer "13 is unlucky" (35%) and "there are no unlucky numbers" (40%).

Overall the performance of grade five students on the goal of the nature of science was rated "satisfactory".

Table 13

THE NATURE OF SCIENCE: GRADE 5

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
9	Suspend judgement if evidence insufficient (response to rare animal sighting)	67	very satisfactory
21	Recognition of scientific thinking (light bulbs #1 and #2)	63	very satisfactory
8	Intellectual honesty (reporting results-boiling syrup)	43	satisfactory
7	superstition (identifying "unlucky numbers" in science)	40	weak
	AVERAGE PERCENT	Total - 53.0 Female - 54.0 Male - 52.0	OVERALL RATING FOR THIS GOAL satisfactory

ATTITUDE RESULTS

Results for the attitude items are discussed below and in the Comparisons section. For a detailed presentation of the data see the Preliminary Report: Test Data.

Interest in science and science-related activities. There were three items in this attitude area at the grade five level.

			Agree	Undecided	Disagree
#1	I would like to study more science	Female	77%	18%	5%
		Male	78%	15%	7%
5	I like to watch science programs on television	Female	58%	19%	23%
		Male	72%	13%	15%
6	I like to read about things that involve science	Female	60%	23%	17%
		Male	70%	17%	13%

The results suggest that the grade five student has a strong interest in science. There is a tendency for males to be somewhat more interested than females. When the original five-point scale is considered, major differences show up with more males responding in the "strongly agree" category. This trend persists throughout all three items.

Attitude toward scientists and science-related ideas. There were two items in this attitude area at the grade five level.

			Agree	Undecided	Disagree
#2	Scientists do more harm than good	Female	11%	19%	70%
		Male	15%	15%	70%
3	Science is very important to our lives	Female	86%	8%	6%
		Male	87%	7%	5%

The results would suggest that grade five students have a positive attitude toward science.

Interest in science as a career. One item assessed student interest in a science-related job.

			Agree	Undecided	Disagree
#4	A job in a scientific field would be interesting.	Female	66%	24%	10%
		Male	75%	16%	8%

The results indicate a positive overall agreement with the statement, with males responding "strongly agree" more than females.

SUMMARY

Grade five student performance on knowledge and comprehension of science content was more than satisfactory, while performance on application of science content was mixed, showing some weaknesses in earth and space science.

Student performance was more than satisfactory on integrated processes and on higher cognitive level thinking. Performance was satisfactory on basic processes, nature of science and safety. Overall grade five students' attitudes and interests toward science were very positive.

CHAPTER III

GRADE EIGHT RESULTS

Grade eight provincial results and interpretation ratings for each goal or general objective are analyzed and discussed in this chapter. Comparisons with grade five and eleven results are presented in Chapter V and teacher survey results are in Chapter VI. Recommendations arising from the Science Assessment are presented in Chapter VII.

The Science Assessment Program 1980 collected and analyzed science test results for a 10 percent sample of all students in grades five, eight and eleven. The test data in the Preliminary Report give, for each test item, the number of students who selected each option. They also give the percentage of students who achieved each possible score or mark on the goal or general objective; these percentages are reported for females, males and total sample.

The distribution of items for the grade eight test was as follows:

	Items
earth and space science--knowledge and comprehension	16
--application	5
physical science--knowledge and comprehension	21
--application	11
life science--knowledge and comprehension	13
--application	4
higher cognitive level - all three content areas	4
basic processes	12
integrated processes	9
safety	4
nature of science	3
attitude	8

ACHIEVEMENT RESULTS

Tables in this chapter present the average percent correct and the median interpretation ratings for each item and goal. Lower "percent correct" scores may obtain a higher interpretation "rating" depending on the difficulty of the item. The "overall rating for goal" is not an average of the ratings listed for each item. Instead, it is the median of a separate, global judgement of student performance on the goal made by the same teachers who made the item-by-item ratings.

Earth and Space Science--Knowledge and Comprehension

A wide variety of topics was encompassed by the sixteen items in this area. There were items on space/time relationships, aspects of the solar system, temperature and weather, fossils, soil, earth science and water pollution.

Descriptions of items, percent of students responding correctly to each item, and the median interpretation ratings of teachers are presented in Table 14. The average percentage result for males and females are also given. See page 9 for a discussion of the interpretation rating procedure used.

The grade eight students who responded to these questions scored relatively well on the factual recall astronomy questions regarding the period of revolution of the earth, the sun being a star, why the sun is visible only in the daytime, why the moon gives light, and recalling details of the solar system. They had more difficulty in remembering why we have the warmest weather in summer. Many gave the reason that the sun was nearest the earth in summer.

Questions on names of 3-dimensional objects brought interesting responses. Seventy-nine percent could call a soft drink can "cylindrical", but only 51 percent could identify a ball as a sphere, earning this a rating of "marginally satisfactory". Many used the 2-dimensional term, "circle".

Weather related questions ranged from 34 percent to 69 percent correct. Naming the month when the noon temperature is 30° Celsius was easiest for the students; next was the change of state question on dew formation. Most difficult for the students (only 34 percent correct) was picking the correct response for the item asking when evaporation occurs. Perhaps this style of question is difficult for them. Thirty-three percent picked the response "when the sun is shining" which was in itself correct: the best answer was the response "all of the above". Performance on this item was rated "weak".

The three earth science questions were on different topics. Many (64 percent) could check the best definition for a fossil, but only 45 percent were able to select the correct essential components of soil, as many forgot the component "air". Forty-five percent also knew the difference between weathering and erosion.

The question on bacterial pollution in water scored very low (21 percent): possibly the vocabulary may have been difficult or the concepts not taught at this grade level.

Overall, student performance on this goal was rated "satisfactory"; performance on seven out of sixteen items was rated "very satisfactory".

Table 14

EARTH AND SPACE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
15	Period of revolution of the earth	82	very satisfactory
9	Sun is a star	81	satisfactory
10	Sun visible only in the daytime	79	very satisfactory
8	Name of a 3-D object--cyclindrical	79	very satisfactory
16	Why moon gives light	72	very satisfactory
4	Month when noon temperature is 30°C	69	marginally satisfactory
12	Name the largest planet in Solar System	67	very satisfactory
20	Definition of a fossil	64	very satisfactory
1	Change of state--dew	63	satisfactory
18	Names of bodies in the Solar System	61	very satisfactory
13	Name of a 3-D object--sphere	51	marginally satisfactory
7	Sun's rays in summer	50	satisfactory
19	Difference between weathering and erosion	45	satisfactory
23	Essential components of soil	45	satisfactory
3	Definition of evaporation	34	weak
6	Bacterial pollution of water	21	weak
	AVERAGE PERCENT Total -	60.1	OVERALL RATING OF GOAL
	Female -	57.9	
	Male -	62.1	Satisfactory

Earth and Space Science--Application

Five items on the test dealt with the application level of earth and space science. They were concerned with air and air pressure, heat from the sun's rays, stream erosion, and the sorting of pebbles in water. For all of these items, responses were less than sixty percent correct.

Table 15 gives the average provincial percent correct together with the median ratings of teachers (see page 9 for the interpretation rating procedure used).

The two questions scoring above 50 percent and rated as "satisfactory" were those dealing with applying knowledge about the angles of the sun's rays with regard to greatest heating capacity, and applying the concept that air occupies space. The remainder of the questions scored 40 percent or lower. These dealt with sorting of sand and pebbles in a jar, determining where stream erosion is the greatest, and applying understanding of air pressure in a straw holding up a column of water. Misinterpretation was possible on the "pebbles in the jar" item. Grade eight students' performance on these items was rated as "weak" or "marginally satisfactory".

Overall interpretation rating of performance on this goal was "marginally satisfactory".

Table 15

EARTH AND SPACE SCIENCE--APPLICATION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
11	Angle of heat from sun's rays	58	satisfactory
2	Applying concept that air occupies space	53	satisfactory
17	Predicting sorting pattern of sand and pebbles	40	weak
21	Determining area of greatest stream erosion	40	marginally satisfactory
5	Applying knowledge of air pressure	31	weak
	AVERAGE PERCENT Total -	44.0	OVERALL RATING FOR GOAL
	Female -	38.0	
	Male -	49.8	marginally satisfactory

Physical Science--Knowledge and Comprehension

The twenty-one assessment items in this area dealt primarily with the molecular nature of matter, light, state of matter, and electricity. There was a heavy emphasis on recognizing the terminology associated with these areas. The results and interpretation ratings are presented in Table 16.

A majority of grade eight students (50 percent to 76 percent) were able to answer correctly the questions concerned with the temperature of ice/water and steam, the relationship between molecular motion and temperature, reflection of light, straight line propagation of light, the process of evaporation, the chemical test for starch, methods for recovering salt from solution, battery-bulb circuitry, and definition of matter. Most of these questions are at the level of comprehension as opposed to pure fact, and performance on these items was rated as "satisfactory" or "very satisfactory".

Table 16

PHYSICAL SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
32	Molecular motion above evaporating water	76	very satisfactory
44	Relating shape to kind of material	76	very satisfactory
48	Molecular motion change with temperature change	75	very satisfactory
53	Iodine test for starch	64	very satisfactory
43	Relationship between angle of reflection to angle of incidence	64	satisfactory
52	Definition of matter	62	satisfactory
37	Straight line propagation of light	62	satisfactory
51	Recovering salt from a solution	61	strength
34	Temperature of water in gaseous state	58	satisfactory
33	Temperature of ice water mixture	51	satisfactory
26	Recognizing complete circuit for battery and bulb	50	satisfactory
39	Describing the image on a camera film	48	satisfactory
27	Identifying series circuits for battery and bulbs	41	satisfactory
25	Relating current used to appliance	35	weak
30	Defining force	34	satisfactory
42	Refraction of white light through a prism	30	weak
47	Nature of a gas	29	weak
38	Definition of umbra and penumbra	29	weak
36	Definition of translucent	29	weak
40	Definition of luminous	28	weak
55	Know colour change of litmus	28	weak
	AVERAGE PERCENT	Total - 49.0	OVERALL RATING FOR GOAL
		Female - 45.9	satisfactory
		Male - 51.9	

Questions answered correctly by many grade eight students (34 percent to 50 percent) dealt with series circuitry, definition of force (although this question was put in the negative form which seems to have confused the students), the image formed in a camera, and electrical power consumption. Performance on these items was rated "satisfactory".

Questions which seemed to present the most difficulty to grade eight students were concerned largely with the definition of the terms translucent, umbra, penumbra, and luminous. Students also did not recall the colour change for litmus paper. They were generally unable to describe the nature of a gas and were not sure which colour of the white light spectrum is refracted most through a prism. Eighteen percent of the grade eight students thought that a flourescent light used more current than an element of an electric stove. Performance on these seven items was rated "weak".

Overall the performance of students on this goal was rated "satisfactory".

Physical Science--Application

The eleven assessment items on application in the physical sciences were generally concerned with simple machines, heat, solutions, magnetism, sound, and chemical change. Several of the questions involved metric measurement as well.

Table 17 gives the provincial percent correct together with the median interpretation ratings of teachers.

In physical science at the application level, the grade eight students did best (88 and 72 percent) on the liquid thermometer item. A question on unbalanced forces, involving a numerical relationship, was answered correctly by half the students; this performance was rated "weak"

Thirty-four to fifty percent of the grade eight students responded correctly to questions in the areas of controlling combustion, types of thermometers, saturated solutions, law of attraction for magnets, sound in a vacuum, and the fact that a gas will fill its container. Performance on three of these items was rated "weak".

The grade eight students had the most difficulty (23 to 29 percent correct) in the practical application of the water trap in a wash basin and in knowing that wood turning black over a flame represents a chemical change. Thirty-one percent of the grade eight students thought that salt dissolving in water was a chemical change.

Overall student performance on this goal was rated "marginally satisfactory". Performance on five of the eleven items was rated "weak".

Table 17

PHYSICAL SCIENCE--APPLICATION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
31	Direction of force and effort for a single pulley	88	very satisfactory
28	Principle of a liquid thermometer	72	strength
29	Combining unbalanced forces	51	weak
54	Controlling combustion	49	satisfactory
35	Recognizing the scale of a thermometer as Celsius	47	weak
50	Identifying a saturated solution	39	satisfactory
24	Deducing the law of repulsion for magnets	38	weak
41	Sound in a vacuum	36	marginally satisfactory
45	Knowing that a gas fills its container	34	weak
49	The principle of a water trap in a basin	29	marginally satisfactory
46	Recognizing a chemical change	23	weak
	AVERAGE PERCENT	Total - 45.7 Female - 42.8 Male - 48.5	OVERALL RATING FOR GOAL marginally satisfactory

Life Science--Knowledge and Comprehension

Life science questions for the grade 8 test were based upon objectives relating to cell structure and function, the role of green plants in photosynthesis, and the characteristics of common groups of animals including humans. Table 18 presents percent correct and interpretation ratings.

Most grade eight students know that caterpillars become butterflies, cats eat meat; the function of the lungs is to take up oxygen, and cells are the units of life. Performance on these items was rated as "very satisfactory" or "strength". Fewer students knew that seeds come from flowers or how germs cause illness. Fewer still could recognize the equation for photosynthesis. However, performance on these items was rated as "satisfactory" Knowledge of fermentation by yeast and that only birds have feathers was shown by less than half of grade eight students. Performance on these items was rated "marginally satisfactory".

Items where performance was rated "weak" were in knowledge and comprehension of cell structure and function. Over half of the students did not know the function of the cell nucleus, and over two thirds did not know that sugar is produced in leaves and that sugar and oxygen are produced in photosynthesis.

Overall, knowledge and comprehension of life science by grade eight students was rated as "satisfactory".

Table 18

LIFE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
68	Caterpillars become butterflies	85	strength
74	Members of the cat family eat meat	81	strength
72	Oxygen enters the blood through the lungs	74	very satisfactory
71	Cells are the units of life	71	very satisfactory
67	Seeds come from flowers	64	satisfactory
59	Germs cause illness by releasing toxins	56	satisfactory
58	Cell nucleus controls cell activity	47	weak
56	Fermentation is caused by yeasts	43	marginally satisfactory
69	Identify feathers as unique to birds	41	marginally satisfactory
64	Identify the equation for photosynthesis	36	satisfactory
65	Sugar is produced in leaves	32	weak
61	Sugar and oxygen are produced in photosynthesis	31	weak
57	Only plant cells have a cell wall	29	weak
	AVERAGE PERCENT	Total - 53.1 Female - 52.7 Male - 53.5	OVERALL RATING FOR THIS GOAL satisfactory

Life Science--Application

Percentage of students responding correctly to items requiring application of biological principles and the rating of these percentages are presented in Table 19.

The interpretation ratings indicate application of biological principles to be a strength at the grade eight level.

Table 19

LIFE SCIENCE--APPLICATION: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
73	Note the absence of vegetables in a diet	89	strength
60	Explain the preservation of milk when cold as slowing of bacterial growth	82	strength
62	Predict the effect on plants if there was no sun	73	very satisfactory
66	Predict the effect on plants deprived of chlorophyll	73	strength
	AVERAGE PERCENT Total -	78.8	OVERALL RATING FOR THIS GOAL
	Female -	80.0	
	Male -	77.8	strength

Higher Cognitive Level - All Three Content Areas

Four items of the test were at the higher cognitive level. These items were in areas of ecology, rotation of the earth and weathering. Table 20 gives the provincial percent correct together with the interpretation ratings.

Items in this section generally involve scientific deduction. At this "higher" cognitive level the grade eight students did best on the item dealing with the effect of weathering upon people in cities (54 percent), and poorest on the item which calls for evidence that the earth turns upon its axis (17 percent). Terms such as rotation and revolution should probably be stressed more in general instruction. It is acknowledged that the sample of items is quite small. Performance expectations here are naturally quite high. In addition it is possible that success on these items depended in part on understanding of the terminology.

Performance on most items and on the overall goal was rated "weak".

Table 20

HIGHER COGNITIVE LEVEL: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
22	The effects of weathering upon people in cities	54	satisfactory
70	The effect of removing an element from a food chain	34	weak
63	The effect of green plants upon human life	27	weak
14	Evidence that the earth rotates upon its axis	17	weak
	AVERAGE PERCENT Total -	33.3	OVERALL RATING FOR GOAL
	Female -	31.3	
	Male -	35.3	weak

Basic Processes

Two levels of science processes were examined - basic processes and integrated processes. For a summary of the science processes see page

Descriptions of the twelve grade eight basic process items are presented in Table 21. Included in the table are the percentage of students responding correctly and the teacher interpretation ratings.

On seven of the twelve basic process items, the students achieved 60 percent or better correct. Performance on all but one of these was rated as "very satisfactory". Students were most successful on the reading-a-thermometer item, with slightly less success on observation and classification items. Distinguishing between observing and inferring, and rounding to the nearest tenth of a unit with linear measurement, were correctly done by only approximately 30 percent of students. These performances earned a rating of "weak".

Ratings of the grade eight basic process items were satisfactory or better for ten of the twelve items with the remaining two being rated as weak. Overall performance on basic processes was rated "satisfactory".

Table 21

BASIC PROCESSES: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
78	Measurement: reading a thermometer	87	very satisfactory
93	Observation: matching bird bills to role descriptions	76	very satisfactory
91	Classification: placing plant leaves in families	70	very satisfactory
76	Inferring and the need for reliable data	67	very satisfactory
77	Observing: Nature of Science and concluding	66	very satisfactory
80	Linear measurement: choosing appropriate units for object being measured	60	marginally satisfactory
95	Operationally defining a bicycle	60	very satisfactory
86	Observation: Distinguishing the term "observation" from several other "Nature of Science" terms	57	satisfactory
81	Measurement: Operation of a Pan Balance choosing side for object placement	42	satisfactory
83	Measurement: Volume of irregular objects and the displacement of water	41	satisfactory
89	Distinguishing between observing and inferring	32	weak
75	Linear measurement: Rounding to the nearest tenth of a unit	30	weak
	AVERAGE PERCENT	Total - 59.3 Female - 61.3 Male - 57.3	OVERALL RATING FOR GOAL satisfactory

Integrated Processes

Data on nine integrated process items are presented in Table 22.

The majority of pupils performed well on communication/graphing items and on prediction in relation to graphing, where either interpolation or extrapolation were demanded. Students did not demonstrate well the more precise use or understanding of experimenting or hypothesizing particularly when variable relationships were involved. While the definition of hypothesizing was known to 54 percent of pupils, the identifying of variables in relation to experimenting was done correctly by less than 20 percent of the students.

Performance of the grade eight students was rated "satisfactory" or better on six of the nine integrated process items. Student response to the item "controlling of variables when growing seeds" was rated a "strength".

Overall performance on integrated process was rated as "satisfactory".

Table 22

INTEGRATED PROCESSES: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
79	Controlling Variables: Growing seeds	73	strength
82	Communicating/Predicting: Interpolation on a bar graph	69	satisfactory
84	Communicating/Predicting: Interpolation on a line graph	69	satisfactory
92	Controlling Variables: Hypothesizing	56	satisfactory
85	Communicating/Predicting: Extrapolation on a line graph	55	satisfactory
90	Hypothesizing: Definition	54	satisfactory
88	Experimenting: Two-variable definition	36	weak
94	Experimenting/Controlling Variables: Making conclusions	24	weak
87	Experimenting: Identifying variables from graphed data-responding variable	18	weak
	AVERAGE PERCENT Total -	50.4	OVERALL RATING FOR GOAL
	Female -	50.8	
	Male -	50.2	satisfactory

Safety

Of the four items selected to assess "safety" three were concerned with different problems associated with heating of substances. A fourth item related to proper sanitation. The results are presented in Table 23.

Many students seem not to be sufficiently safety conscious, perhaps because of unfamiliarity with a range of laboratory situations. In particular, the potential dangers from intense heating and consequent rapid expansion or explosion were not well understood.

Overall student performance on safety was rated only "marginally satisfactory".

Table 23

SAFETY: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
97	Recognizing danger of steam (from kettle)	65	satisfactory
96	Washing after using pond water	60	satisfactory
99	Precautions for heating in a test tube	59	marginally satisfactory
98	Boiling water in a stoppered flask	24	weak
	AVERAGE PERCENT Total -	52	OVERALL RATING FOR THIS GOAL
	Female -	50.5	
	Male -	53.5	marginally satisfactory

The Nature of Science

The three items in this area were similar to those at the grade five level. They concerned scientific approaches to dealing with observations and data, as well as the idea of the non-capricious nature of science. The results are presented in Table 24.

Performance on the item dealing with "need to suspend judgement until sufficient evidence is presented" was rated "satisfactory". An item dealing with the element of superstition ("lucky" or "unlucky") in science was interpreted to be only marginally satisfactory. Many students (18 percent) fet that scientists would think "thirteen" was unlucky. Finally, student results were inpterpreted to be "weak" in an area requiring intellectual honesty in reporting of results. Students seemed to be very prone to thinking they had made an experimental error when there was lack of agreement of their results with an answer from the text.

Overall the performance of the grade eight students in the area of the nature of science was rated "marginally satisfactory".

Table 24

THE NATURE OF SCIENCE: GRADE 8

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
102	Suspend judgement if evidence insufficient (response to rare animal sighting)	68	satisfactory
100	Superstition (identifying "unlucky" numbers)	68	marginally satisfactory
101	Intellectual honesty (reporting results boiling syrup)	46	weak
	AVERAGE PERCENT	Total - 60.7 Female - 65.0 Male - 57.0	OVERALL RATING FOR GOAL marginally satisfactory

ATTITUDE RESULTS

Results for the attitude items are discussed below and in the Comparisons section. For a detailed presentation of the data see the Preliminary Report: Test Data.

Interest in science and science-related activities. There were four items in this attitude area at the grade eight level.

			Agree	Undecided	Disagree
# 104	I would like to study more science	Female	43%	31%	24%
		Male	48%	24%	23%
106	I like to watch science programs on television	Female	34%	27%	37%
		Male	52%	18%	24%
107	I like to read about things that involve science	Female	28%	30%	38%
		Male	41%	27%	27%
109	Science class is my favorite class	Female	20%	26%	49%
		Male	25%	24%	46%

The results suggest that grade eight students' interest in science and science-related activities is mixed. Many students were disinterested or undecided. Males were somewhat more interested in science than females.

Attitude toward scientists and science-related ideas. There were three items in this attitude area at the grade eight level.

#	Item		Agree	Undecided	Disagree
# 103	Scientists do more harm than good	Female	9%	22%	66%
		Male	13%	18%	64%
105	Scientists are usually "odd" people	Female	12%	17%	67%
		Male	17%	17%	61%
110	Science is very important to our lives	Female	79%	11%	5%
		Male	76%	11%	7%

The results here suggest a positive attitude toward scientists and science-related ideas on the part of grade eight students. Females were somewhat more positive in attitude than males.

Interest in science as a Career

#	Item		Agree	Undecided	Disagree
# 108	A job in a scientific field would be interesting	Female	49%	26%	20%
		Male	55%	22%	18%

The results indicate overall agreement with the statement, with males agreeing more than females.

SUMMARY

Grade eight student performance was satisfactory on knowledge and comprehension of science content, and on basic and integrated processes. Performance was less than satisfactory on higher cognitive level thinking, and nature of science and safety. Student performance on application of science content was mixed, showing some weaknesses in earth and space and in physical science. Overall grade eight students' attitudes and interests toward science were marginally positive.

CHAPTER IV

GRADE ELEVEN RESULTS

This chapter attempts to analyze and discuss the grade eleven provincial results and interpretation ratings for each goal or general objective. Comparisons with grade five and eight results are presented in Chapter V and teacher survey results are in Chapter VI. Recommendations arising from the Science Assessment are presented in Chapter VII.

The Science Assessment Program 1980 collected and analyzed science test results for a 10 percent sample of all students in grades five, eight, and eleven. The test data in the Preliminary Report give, for each test item, the number of students who selected each option. They also give the percentage of students who achieved each possible score or mark on the goal or general objective; these percentages are reported for females, males, and total sample.

The distribution of items for the grade eleven test was as follows:

	Items
earth and space science--knowledge and comprehension	16
--application	4
physics--knowledge and comprehension	12
--application	12
chemistry--knowledge and comprehension	12
--application	16
life science--knowledge and comprehension	13
--application	9
higher cognitive level--all three content areas	7
processes	5
safety	5
nature of science	4
lab technique	3
attitude	8

ACHIEVEMENT RESULTS

Tables in this chapter present the average percent correct and the median interpretation ratings for each item and goal. Lower "percent correct" scores may obtain a higher interpretation "rating" depending on the difficulty of the item. The "overall rating for goal" is not an average of the ratings listed for each item. Instead, it is the median of a separate, global judgement of student performance on the goal made by the same teachers who made the item-by-item ratings.

Earth and Space Science--Knowledge and Comprehension

Sixteen items in this test were in the knowledge and comprehension area of earth and space science. Items were primarily concerned with fossil formation, the rock cycle, the formation of sedimentary and metamorphic rocks, weathering, and the components of soil. Additional questions concerned the sun, the moon, evidence of earth's rotation, space gases, and the expanding universe theory. There were three questions on elements of weather, barometers, and thermometers.

Descriptions of items, percent of students responding correctly to each item, and the median interpretation ratings of teachers are presented in Table 25. The average percentage results for males and females are also given. See page 9 for a discussion of the interpretation rating procedure used.

A majority of students (above 58 percent) responded correctly only on some of the rote memory type questions. On one of this type--to recall the abundant elements of the sun--the students scored only 37%. On questions requiring comprehension the scores were low--from 56 percent down to 8 percent for the expanding universe theory item.

The interpretion ratings for performance on half of the items was "satisfactory" or better. The remaining ratings were "marginally satisfactory" or "weak". Some of the items, such as #6, #21, and #22, may have been subject to misinterpretation by students.

Overall student performance on the goal was rated as "marginally satisfactory". Students at the grade eleven level have a relatively poor knowledge and comprehension in the earth and space science area.

Table 25

EARTH AND SPACE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
5	Expansion of liquids in thermometers	77	very satisfactory
11	Origin of craters of the moon	73	very satisfactory
20	Fossils formed in limestone	62	satisfactory
18	Essential components of soil	58	very satisfactory
4	How a bottle barometer works	56	satisfactory
21	Processes of metamorphism	53	satisfactory
17	Difference between physical and chemical weathering	42	satisfactory
16	Important factors in weathering	40	satisfactory
14	Abundant elements in the sun	37	marginally satisfactory
19	How sedimentary rocks are formed	28	weak
12	Space contains low density gases	27	marginally satisfactory
22	Rock cycle	17	marginally satisfactory
6	Cause of dew formation	17	weak
7	Evidence of earth's rotation	16	weak
9	Same side of moon always visible	16	weak
13	Expanding universe theory	8	weak
	AVERAGE PERCENT - Total -	39.3	OVERALL RATING FOR GOAL
	Female -	35.0	
	Male -	43.6	marginally satisfactory

Earth and Space Science--Application

There were four questions at the application level for grade 11 earth and space science. Two dealt with air and air pressure, one with the phases of the moon, and one with stream erosion.

The results are presented in Table 26 along with the teacher interpretation ratings.

Students scored from 54 percent to 79 percent on these questions. Three out of the four questions also appeared on the grade eight test (see Comparisons section page 60). Student achievement increased significantly (from 20 to 30 points) on ability to apply these concepts. Student achievement was also high in the "phases of the moon" question.

Overall student performance on this goal was rated between "very satisfactory" and "strength".

Table 26

EARTH AND SPACE SCIENCE--APPLICATION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
8	Applying knowledge of phases of the moon	79	strength
1	Applying concept air occupies space	74	strength
15	Determining area where stream erosion greatest	71	very satisfactory
3	Applying knowledge of air pressure	54	satisfactory
	AVERAGE PERCENT -	Total - 69.5 Female - 64.3 Male - 74.8	OVERALL RATING FOR GOAL very satisfactory to strength

Physics--Knowledge and Comprehension

The twelve items in this area were concerned with light, force and work, temperature, magnetic field, heat conductors and solar eclipse.

Table 27 gives the provincial percent correct together with the median interpretation ratings of teachers (see page 9 for the interpretation rating procedure used).

Many grade eleven students responded correctly (57 to 81 percent) to items on solar eclipses, direction of propagation of light, magnetic field about a current carrying conductor, radiation of energy from sun to earth, description of image in a camera, and identifying temperature scales. The questions here were approximately 50 percent knowledge and 50 percent comprehension. Student performance on these six items was rated "satisfactory" or better, with three "strength" ratings.

Performance on the remaining six items averaged below 50 percent correct and was rated only "marginally satisfactory" or "weak". These were questions on: recognizing materials for their ability to conduct heat; the relationship between input and output for simple machines; the fact that a push or a pull represents a force; and the angle of reflection vs. angle of incidence for a plane mirror (the reflected ray itself was incorrectly identified by 40 percent as the angle of reflection). The grade eleven students did the poorest in the physics areas of identifying a luminous source of light and the refraction of light from air to water (19 and 33 percent).

Overall student performance on this goal was rated "satisfactory", although there are definite weaknesses here.

Table 27

PHYSICS--KNOWLEDGE AND COMPREHENSION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
48	Cause of solar eclipse	81	strength
43	Propagation of light in a straight line	76	very satisfactory
29	Magnetic field about a current carrying conductor	73	strength
40	Radiation energy from sun to earth	67	satisfactory
45	Description of image on a camera film	61	strength
41	Comparison of temperature scales	57	satisfactory
42	Conductors of heat	55	marginally satisfactory
32	Input/output relationship for simple machines	43	weak
30	Recognizing a force as a push or pull	39	marginally satisfactory
47	Comparing the angle of reflection to angle of incidence	37	marginally satisfactory
44	Defining a luminous source of light	33	marginally satisfactory
46	Refraction of light from air to water	19	weak
	AVERAGE PERCENT	Total - 53.4 Female - 49.4 Male 57.5	OVERALL RATING FOR GOAL satisfactory

Physics--Application

Twelve assessment items concerned simple machines, pressure, energy transformation, inertia, induced current, and electricity. Many of the questions involved mathematical calculations and/or interpreting data from either tables or graphs.

Table 28 gives the provincial percent correct together with the median interpretation ratings of teachers.

Many grade eleven students responded correctly (51 to 85 percent) on the items concerning calculating a resulting force, calculating a mechanical advantage for a lever arrangement, comparing household energy consumption, calculating a hydro bill, summarizing experimental data on static electricity, summarizing experimental data on the most practical conductor for wiring a house, and summarizing experimental data on ampere-turns for induced current. Performance on these items was, with one exception, rated "very satisfactory" or "strength".

Less than half of the grade eleven students (35 to 44 percent) responded correctly to items concerning: the concept of inertia and the transfer of energy from a flame to a pan of water. Performance here was rated "satisfactory".

The areas of physics which presented the most difficulty for the grade eleven students at the cognitive level of application concerned calculating force for a pulley arrangement, calculating efficiency for a simple machine and calculating the pressure on a surface given total force and the area of the surface. Performance here was rated "marginally satisfactory" or "weak".

Overall student performance on the goal was rated "satisfactory".

Table 28

PHYSICS--APPLICATION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
31	Resolution of opposing forces	85	strength
35	Calculating mechanical advantages for lever	69	very satisfactory
23	Summarizing household power situations	64	very satisfactory
26	Calculating a hydro bill	63	strength
25	Summarizing data from an experiment	60	satisfactory
24	Interpreting data to determine best conductor	58	very satisfactory
27	Interpreting data re: ampere turns	51	very satisfactory
36	Principle of inertia	44	satisfactory
38	Tracing energy from a flame to water in a pan	40	satisfactory
33	Calculating resulting force for a pulley arrangement	35	marginally satisfactory
34	Calculating efficiency for a simple machine	25	marginally satisfactory
37	Calculating pressure given total force & area	22	weak
	AVERAGE PERCENT Total -	51.3	OVERALL RANKING FOR GOAL
	Female -	48.3	
	Male -	54.3	satisfactory

Chemistry -- Knowledge and Comprehension

There were twelve items at the knowledge and comprehension level for grade eleven chemistry. They covered a range of chemistry content from a simple test for starch to the atomic nature of matter. The results for this section are presented in Table 29.

Table 29

CHEMISTRY--KNOWLEDGE AND COMPREHENSION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEMS	PERCENT CORRECT	RATING
78	Naming instrument used to show spectral flame colors	69	strength
76	Recognizing electron on atom diagram	62	marginally satisfactory
66	Evaporation to recover solid from a solution	60	satisfactory
89	Iodine as a test for starch	54	marginally satisfactory
85	Mass is the most reliable measure for quantity	45	marginally satisfactory
77	Recognition of atomic nature of matter and that molecules can contain one or more atoms	43	satisfactory
75	A gas is made up of randomly moving molecules colliding with container walls and with each other	42	marginally satisfactory
90	Limewater as a test for carbon dioxide	35	weak
72	Distinguish between physical and chemical change	32	weak
87	Blue litmus as a test for an acid	31	weak
88	A base is able to neutralize an acid	22	weak
68	Definition of a suspension	13	weak
	AVERAGE PERCENT Total -	42.4	OVERALL RATING FOR GOAL
	Female -	42.4	
	Male -	42.4	marginally satisfactory

Only four items were answered correctly by over half the students. Items on several chemical tests and simple physical property tests were answered incorrectly by more than half the students. Correct naming of an electron in an outer shell on a Bohr model of an atom was demonstrated by 62 percent, while about one-half of the pupils tested knew that iodine was a test for starch. Approximately half of the pupils knew that mass is the most reliable measure for quantity and even fewer knew that limewater is a test for carbon dioxide. A third of the pupils correctly recognized that blue litmus showed presence of an acid, while even fewer knew that a base is able to neutralize an acid. The item on liquid suspension was answered correctly by only 13 percent. Student perofrmance on only three of the twelve items was rated as "satisfactory" or better. Performance on the remainder of the items was "marginally satisfactory" or "weak".

Overall student performance on the goal was rated only "marginally satisfactory".

Chemistry--Application

Sixteen application level items for grade eleven chemistry included knowledge about physical-chemical properties, about the kinetic molecular theory of matter, and about mixtures, compounds, and elements. These items would be classed more as physical chemistry than as pure chemistry. The results for this section are presented in Table 30.

A majority of students demonstrated a knowledge of physical properties and the states of matter and of the distillation of water and alcohol. Cooling a saturated solution to produce crystallization was known to 60 percent, while slightly more than half of the pupils demonstrated knowledge at the application level for reversible reaction criteria, using freezing as a method of separating liquid mixtures, for using a knowledge of combustion components to control burning, or increasing the rate of evaporation. The application of the kinetic molecular theory of matter was demonstrated by about half of the students, as was the identification of elements using additive spectral principles. Items on mixtures, elements, compounds, conditions for chemical change, and steps in commercial water purification were answered correctly by less than half of the students. When presented with a heating-cooling graph, only one-third of the pupils could correctly relate the inflection or plateau points to freezing points of a substance. It was noted that item 67 had some alternatives that were somewhat ambiguous for students at this level ('melted' versus 'dissolved').

Teacher interpretation ratings were as follows: two items were rated as "weak", one item was "marginally satisfactory", and the remainder of the items were rated "satisfactory" or "very satisfactory". Results for this goal overall were rated "satisfactory".

Table 30

CHEMISTRY--APPLICATION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
82	Physical properties and state of matter	76	very satisfactory
83	Distillation of water and alcohol	75	very satisfactory
79	Crystallization by cooling a saturated solution	60	very satisfactory
63	Criteria for reversible reactions	57	satisfactory
80	Crystallization by freezing as a method of separating two dissimilar liquids	55	satisfactory
91	Controlling combustion by knowing the necessary components for combustion	55	very satisfactory
71	Speeding up the process of evaporation	54	satisfactory
64	Kinetic molecular theory of matter	52	very satisfactory
92	Element identification using additive spectral lines	51	very satisfactory
69	Kinetic molecular theory of matter and compressibility	50	marginally satisfactory
65	Conditions for chemical change	49	satisfactory
70	Mixtures, elements, and compounds: the burning of iron and sulphur	48	satisfactory
86	Steps in commercial water purification	44	satisfactory
84	Separating mixtures using physical properties	40	satisfactory
73	Heating-Cooling Graphs: Heat of Fusion and Vaporization inflection points	33	weak
67	Physical properties and solutions	24	weak
	AVERAGE PERCENT Total	51.6	OVERALL RATING FOR GOAL
	Female	49.6	
	Male	53.4	satisfactory

Life Science--Knowledge and Comprehension

In knowledge and comprehension of life science, students were asked about the function of the lungs, kidneys, and uterus. They were asked the function of the cell nucleus, how to distinguish between plant and animal cells, and the identity of the cell membrane. Other questions related to characteristics of birds, the exosystem, and photosynthesis.

Descriptions of items, percent correct, and interpretion ratings are presented in Table 31.

Only 3 of the 13 items at the level of knowledge and comprehension were rated as satisfactory or above. Most students knew that oxygen entered the blood through the lungs; this was rated as "very satisfactory". Sixty percent could distinguish between a plant and animal cell on the basis of the presence or absence of a cell wall and this was rated as "satisfactory".

Knowledge of the function of the kidneys (49 percent) and uterus (44 percent) was considered marginally satisfactory. Knowledge about cells, which included knowing that the cell nucleus controls cell activity (49 percent) and the difference between plant and animal cells (31 percent), was also considered marginally satisfactory.

Weaknesses were noted in the knowledge that sugar and oxygen are products of photosynthesis (32 percent), in identifying the technique of chromatography (33 percent), and in the knowledge that feathers were distinguishing features of birds (43 percent). The fact that only 14 percent responded correctly that carbon dioxide gas was a major contributor to the mass of tree also indicated a weakness.

Overall performance on the goal was rated as "marginally satisfactory"

Table 31

LIFE SCIENCE--KNOWLEDGE AND COMPREHENSION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
96	Oxygen enters the blood through the lungs	82	very satisfactory
104	Fermentation is caused by yeasts	60	satisfactory
110	Kidneys remove waste from the blood	49	marginally satisfactory
101	Cell nucleus controls cell activity	49	marginally satisfactory
118	Identify producers in a food web	49	marginally satisfactory
98	Identify the cell wall as a distinguishing plant and animal cells	46	satisfactory
105	Name the uterus as the site of human embryo	44	marginally satisfactory
97	Identify feathers as unique to birds	43	weakness
111	Identify the technique of chromatography	33	weakness
108	Sugar and oxygen are produced in photosynthesis	32	weakness
99	Identify the cell membrane in a diagram	31	marginally satisfactory
100	Name the cell wall to distinguish between plant and animal cells	31	marginally satisfactory
106	Carbon dioxide is major contributor to the mass of a tree	14	weakness
	AVERAGE PERCENT Total - 43.3 Female - 41.2 Male - 45.5		OVERALL RATING FOR GOAL marginally satisfactory

Life Science--Application

Application of life science items included classification skills, application of ecological principles, interpretation of the results of Mendelian genetics experiments and evolution.

Descriptions of items, percent of students responding correctly, and interpretation ratings are presented in Table 32.

The interpretation ratings of the percentages of correct responses on the 3 items relating to genetics and evolution were from "satisfactory" to "strength". One item at the application level was rated "weak". Seven percent of grade eleven students were able to identify correctly the role of a pioneer species in ecological succession.

Overall performance on this goal was rated as "very satisfactory".

Table 32

LIFE SCIENCE--APPLICATION: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
103	Identify common structures in a group of mushrooms	82	strength
112	Classify leaves on the basis of common structures	74	very satisfactory
107	Predict the death of plants deprived of chlorophyll	70	very satisfactory
114	Interpret the results of Mendelian experiments in terms of dominant and recessive traits	65	strength
95	Identify the conditions for bacterial growth	62	satisfactory
115	Distinguish between inherited and acquired characteristics	60	very satisfactory
120	Identify the bottom of a biomass pyramid as containing the most energy	44	satisfactory
119	Use the theory of evolution to explain an adaptation	42	satisfactory
117	Explain the role of a pioneer species in ecological succession	7	weakness
	AVERAGE PERCENT	Total - 56.3 Female - 57.9 Male - 54.7	OVERALL RATING FOR GOAL very satisfactory

Higher Cognitive Level--All Three Content Areas

All questions at this cognitive level for the earth sciences, physical sciences and life sciences were combined and labeled "higher". The seven assessment items in this area were primarily concerned with data interpretation and logical deduction. Table 33 gives the percent correct together with the median interpretation ratings of teachers.

Most items in this section involve logical scientific deduction, e.g., proving air has mass, the effect of a break in food chain on an ecology. Grade eleven students were best in areas involving data interpretation. They were less successful in making logical deductions from narrative description. Some of the weaker responses occurred toward the end of the test and questions with longer descriptive stems were missed most often.

Overall student performance on this goal was rated as "satisfactory".

Table 33

HIGHER COGNITIVE LEVEL: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
81	Comparing chemical substances	61	very satisfactory
2	Proving air has mass	58	satisfactory
74	Interpreting a melting curve	57	very satisfactory
116	Effect of break in food chain on ecology	43	marginally satisfactory
28	Data interpretation re: ampere - turns	32	satisfactory
109	Effect of loss of green plants upon humans	32	weak
113	Conservation of mass deduction	26	weak
AVERAGE PERCENT	Total -	44.0	OVERALL RATING FOR GOAL satisfactory
	Female -	41.3	
	Male -	46.7	

Processes of Science

The processes of science were not well represented at the grade eleven level with only five process items in the section. The results and interpretation ratings related to the five items are presented in Table 34.

A majority of grade eleven students did not obtain correct responses on four of the five items. Linear measurement with the object not aligned at zero, hence with two additive estimations of error forming a part of the length estimation, was performed correctly by only 38 percent of grade eleven students. The measurement of the volume of an irregular object using water displacement was done correctly by 50 percent of the students. The observing (greenhouse-seedling) question, which required careful reading, was answered correctly by fewer than half of the students.

Interpretation ratings were "satisfactory" or better for three of the items, while two were rated "marginally satisfactory". Overall student performance on the goal was rated "satisfactory".

Table 34

PROCESS OF SCIENCE: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEMS	PERCENT CORRECT	RATING
60	Hypothesizing: As a prediction, only	82	strength
58	Measurement: Irregular volume by displacement of water	50	satisfactory
52	Measurement: Selection of appropriate instruments for variety of uses	48	satisfactory
54	Measurement: Linear distance, object not at zero, with error estimation	38	marginally satisfactory
94	Observing: Data collection, and concluding from data	38	marginally satisfactory
	AVERAGE PERCENT	Total - 51.0 Female - 49.6 Male - 52.4	OVERALL RATING FOR GOAL satisfactory

Safety

Four fairly distinct aspects of safety were assessed at the grade eleven level. The results are presented in Table 35.

Overall student performance on the items was relatively poor. While some of the items themselves were somewhat complicated, with different combinations of points used to make up several of the foils, student results were generally considered low in this area.

Overall the interpretation rating for this goal was "marginally satisfactory".

Table 35

SAFETY: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
93	Appropriate use of fire-blanket	82	very satisfactory
56	Safety with glass tubing and stoppers	53	marginally satisfactory
57	Chemical gas generators may build excessive pressure	45	weak
55	Dealing with excess chemical reagent	41	marginally satisfactory
	AVERAGE PERCENT Total -	55.0 54.0 56.0	OVERALL RATING FOR THIS GOAL marginally satisfactory

The Nature of Science

Five items were included under nature of science. These items dealt with making inferences and conclusions based on reliable data, best methods of collecting and dealing with experimental data, and identifying an instrument as an extension of one of the senses. The results for the nature of science items are presented in Table 36.

Responses to two items dealing with making of inferences (#53) and conclusions (#49) based on reliable data were rated as "strength". Remaining responses to items in the group were rated as "very satisfactory". These included items dealing with identifying an instrument as an extension of one of the senses (#50), choosing the best method of collecting data (#51), and selecting the most accurate test of a hypothesis (#25). Where students did not select the correct answers, they often chose foils which were quite plausible in that they were legitimate operations - if not the correct ones.

On the whole the performance of the grade eleven students in the area of the nature of science was rated "very satisfactory".

Table 36

THE NATURE OF SCIENCE: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
53	Recognition of scientific thinking (light bulbs #1, and #2)	90	strength
49	Conclusions based on data (owl hooting: rain)	81	strength
50	Smoke detector as extension of senses	75	very satisfactory
51	Selecting best method of collecting data	70	very satisfactory
25	Increasing accuracy by increasing trials	60	very satisfactory
	AVERAGE PERCENT Total -	75.2	OVERALL RATING FOR GOAL
	Female -	76.6	
	Male -	74.0	very satisfactory

Laboratory Techniques

Three items were included under the heading laboratory techniques, and this area was tested at the grade eleven level only. Items concerned the reason for using boiling chips, identification of a suitable gas collection method for an alka-selzer/water reaction, and identification of optimum conditions for dissolving sugar in water. The results for laboratory techniques are presented in Table 37.

Even in their best item (#62) students in large numbers selected a wide range of incorrect foils (between eight and fifteen percent correct for each of the remaining foils). Judging by the broad range of answers given, it appeared that students simply did not understand conditions for increasing solubility, or the purpose of boiling chips. They seemed even less familiar with selecting a gas collection method (#59).

Overall the interpretation rating of student performance in this area was "marginally satisfactory".

Table 37

LABORATORY TECHNIQUES: GRADE 11

ITEM NUMBER	DESCRIPTION OF ITEM	PERCENT CORRECT	RATING
62	Conditions for increasing solubility	58	satisfactory
61	Purpose of boiling chips	48	weak
59	Naming a gas collection method	35	weak
	AVERAGE PERCENT Total -	47.0	OVERALL RATING FOR GOAL marginally satisfactory
	Female -	46.3	
	Male -	48.0	

ATTITUDE RESULTS

Results for the attitude items are discussed below and in the Comparisons section. For a detailed presentation of the data see the Preliminary Report: Test Data.

Interest in science and science-related activities. There were four items in this attitude area at the grade eleven level.

#	Item		Agree	Undecided	Disagree
# 122	I would like to study more science	Female	36%	35%	25%
		Male	47%	28%	21%
124	I like to watch science programs on television	Female	36%	23%	37%
		Male	57%	15%	24%
125	I like to read about things that involve science	Female	29%	27%	40%
		Male	47%	24%	25%
127	Science class is my favorite class	Female	16%	24%	55%
		Male	25%	24%	45%

The results suggest that grade eleven students interest in science and science-related activities was mixed. Many students are disinterested or undecided. Males were somewhat more interested in science than females. The results for the last item above should be interpreted cautiously as many students in grade eleven do not have science classes at all.

Attitude toward scientists and science-related ideas. There were three items in this attitude area at the grade eleven level.

#	Item		Agree	Undecided	Disagree
# 121	Scientists do more harm than good	Female	5%	20%	71%
		Male	10%	18%	68%
123	Scientists are usually "odd" people	Female	12%	14%	70%
		Male	18%	17%	61%
128	Science is very important to our lives	Female	84%	6%	4%
		Male	80%	7%	7%

The results here suggest a very positive attitude toward scientists and science-related ideas on the part of grade eleven students. Females were somewhat more positive in attitude than males.

Interest in science as a career. One item assessed student interest in a science-related job.

			Agree	Undecided	Disagree
# 126	A job in a scientific field would be interesting	Female	52%	23%	20%
		Male	52%	25%	17%

The results indicate overall agreement with the statement, with males and females agreeing equally.

SUMMARY

Grade eleven student performance was more than satisfactory on nature of science and on application of science content. Performance was satisfactory on higher cognitive level thinking and on processes of science. Student performance on safety and laboratory technique was less than satisfactory, as was knowledge and comprehension of science content. Overall grade eleven students' attitudes to, and interests in, science were marginally positive.

CHAPTER V

COMPARISONS

The assessment tests were structured to facilitate three sets of comparisons. Firstly, common goals were assessed from grade level to grade level, so that certain trends in goal achievement within and across grade levels may be noted. Secondly, results were analyzed separately for males and females, so that achievement differences according to sex may be examined. Finally, particular items were made common to two or more grade levels, so that trends on these common items may be analyzed.

TRENDS IN GOAL ACHIEVEMENT

Table 38 below summarizes goal interpretation ratings from grade to grade. Both average percent correct scores and interpretation ratings for the goals can be used to examine trends. These trends should be interpreted cautiously however as in each case different age groups of students, different sets of items, and different sets of performance expectations are involved.

Knowledge and comprehension

Grade five student performance on knowledge and comprehension of science content was more than satisfactory. The knowledge and comprehension of science content performance of grade eight students was rated consistently "satisfactory". Performance of grade eleven students was low; three of four ratings were "marginally satisfactory".

Application

The application of science content performance of grade eleven students was consistently higher than their performance on knowledge and comprehension; grade eleven application ratings were either "satisfactory" or "very satisfactory". Grade eight students' performance was low, with two "marginally satisfactory" ratings. Performance of grade five students was mixed.

Higher cognitive level

Grade five students' performance was "very satisfactory" on higher cognitive level thinking, whereas grade eight student performance was "weak". Performance ratings do not parallel the percent correct scores for these items. Scores are low for both grades five and eight students and increase slightly at the grade eleven level, earning a rating of "satisfactory".

Processes of science

Performance of grade five students on processes of science was "satisfactory" and "strength". Performance on the processes of science items gradually decreases through the grades. Performance of grade eight and grade eleven students was rated "satisfactory".

Table 38

TRENDS IN GOAL ACHIEVEMENT: INTERPRETATION RATINGS

GOAL	GRADE 5	GRADE 8	GRADE 11
Knowledge and Comprehension			
Earth and Space	very satisfactory	satisfactory	marginal
Physical	satisfactory	satisfactory	P sat. C marginal
Life	very satisfactory	satisfactory	marginal
Application			
Earth and Space	weak to marginal	marginal	very satisfactory
Physical	satisfactory	marginal	P sat. C sat.
Life	satisfactory	strength	very satisfactory
Higher Cognitive Level	very satisfactory	weak	satisfactory
Processes	B satisfactory I strength	B satisfactory I satisfactory	satisfactory
Nature of Science	satisfactory	marginal	very satisfactory
Safety	satisfactory	marginal	marginal
Lab Technique	--	--	marginal

B - Basic Processes
I - Integrated Processes
P - Physics
C - Chemistry

Nature of science

Performance on nature of science increases consistently from grade five through grade eight to grade eleven. As with higher cognitive level thinking, performance ratings here do not parallel the percent correct scores. Grade five students achieved a "satisfactory" rating, and grade eight students a "marginally satisfactory" rating. Performance of grade eleven students was more than satisfactory.

Safety, and lab technique

Safety maintained a 50 to 55 percent success rate at grade eight and eleven levels, in both cases earning a rating of "marginally satisfactory". Further, at the grade eleven level, "laboratory technique" was rated as "marginally satisfactory". Grade five students performance was rated as "satisfactory" although the low percentage correct was noted.

ACHIEVEMENT DIFFERENCES ACCORDING TO SEX

Differences at the grade five level between males and females are small or negligible for all goals. There do not appear to be any appreciable differences on processes of science, on nature of science or on higher cognitive level thinking which generally include such skills as analysis, synthesis and evaluation. The differences are most pronounced in knowledge and comprehension of physical science.

Some trends which are evident at the grade five level continue in grade eight. Accordingly on both knowledge and comprehension and application areas, males outperform females, especially in earth and space and in physical science, but performance on life science does not differ appreciably. There is a slight tendency favouring females on application of life science and on nature of science.

There was a tendency favoring males on higher cognitive level thinking while there was a similar tendency favoring females on basic processes. There is no appreciable difference between the sexes on integrated processes at the grade eight level.

The grade eleven data indicate a continuation of the persistent, definite trends which were evident at the grade eight level. Thus on both knowledge and comprehension and application, males again outperform females in earth and space and in physical science. When chemistry is considered alone at the knowledge and comprehension level, however, females do not perform differently from males.

Males outperform females on higher cognitive level thinking, and are slightly higher on processes of science. Females outperform males on the application of life science and on the nature of science at the grade eleven level.

TRENDS ON COMMON ITEMS

Some test items were placed at more than one grade level to assess students' growth in understanding of certain key ideas. Appendix 1 presents the comparison data on common items: on all but three items there was an increase in percent correct from the lower to the higher grade level. This section summarizes these trends across grade levels. These trends should be interpreted cautiously as different age groups of students are involved.

Application and higher cognitive level items increase 20 percent on the average from grade five to grade eight (except for one deviant item). An even greater increase occurs from grade eight to grade eleven; the ability to function at application and higher cognitive levels increases with age. Items at a knowledge and comprehension level show smaller increases from grade to grade. For the "conservation of matter" item, responses indicate a marked increase in attainment of conservation of matter from grades five to eight consistent with Piagetian research data.

Increases in the success rate for the nature of science items were very small between grades five and eight with the exception of the "lucky number" items (grade 5, #7) where the increase is 28 percent. The increase from grade eight to eleven, on the one relevant item, is much greater (see appendix I).

There were four cross-grade comparison process items. For the "control of variables" item (grade 5, #12), the younger children did very well, with relatively little change for grade eight. For the two items common to grade eight and grade eleven, there was a much greater increase. This repeats the trends noticed on other goals.

TRENDS ON COMMON ATTITUDE ITEMS

Each of grades five, eight and eleven had three identical items relating to "interest in science". Grades eight and eleven shared another identical item. Overall, science interest was very high in grade five, then waned markedly, but remained slightly positive in grades eight and eleven. Males were more positive than females in every area of interest in science and science-related activities that was tested.

A second set of common items concerned attitude toward scientists and science-related ideas. There is remarkable consistency across grades in attitudes in this area, especially when "disagree" responses are taken into account. A marked shift toward stronger agreement with the statement "science is very important to our lives" is noted from grade five through grade eleven. Overall, females are slightly more positive than males in attitude toward scientists and science-related ideas.

One item in each of the three grades assessed student interest in a job in a scientific field. The results indicate overall agreement with the statement. Grades eight and eleven responses were similar, but less positive than grade five responses. Males responded "strongly agree" more than females at each grade level. This may suggest that science is viewed somewhat by students as a male-oriented field.

CHAPTER VI

TEACHER SURVEY

The teacher survey was designed to collect information which would assist in the general interpretation of the student assessment data. Such factors as the time spent in the classroom, materials available, degree of implementation of the new guide, and the attitude and background of the teachers, should be considered when the reader seeks a rationale for particular assessment results. The data will not establish cause-and-effect relationships, but will give a cross-section of opinion and background. The general information obtained will not explain specific student results, but will establish generalities regarding programs. Teachers of science in grades five, eight, and eleven were surveyed as their students were participating in the assessment. Recommendations based on the teacher survey data are presented in Chapter VII.

THE SURVEY

The survey consisted of three questionnaires for the grade five, grade eight, and the grade eleven science teachers respectively. The questionnaires were designed to assess the teaching practices that are occurring in the science classrooms of Manitoba, the opinions of teachers on a number of topics, the degree of implementation of the recently developed science curricula, information concerning the facilities and equipment available for science instruction, and teacher background information.

During the development stage, each questionnaire was critically examined by the Science Technical Advisory Committee and the Joint Committee on Evaluation. Revisions were made based on information from these groups. The final questionnaires are included in Appendix 2 of this document.

Questionnaires were mailed to all public schools in the province just prior to the student test date of 19 November 1980. All teachers of science at grades five, eight, and eleven were requested to complete and return the questionnaires. Sufficient copies were mailed to each school. The questionnaires were self administered, strict confidentiality was maintained, and the questionnaires were returned anonymously. Results were analyzed for the province as a whole with no individuals, schools, or school divisions being identified. Provincial results (percentages or median responses) are also included in Appendix 2 of this document.

DEMOGRAPHIC DATA AND TEACHER PREPARATION AND EXPERIENCE

Several items from the teacher survey gave relevant background information about the grade five, grade eight, and grade eleven science teachers of Manitoba. These items dealt with what science courses they are now teaching and have previously taught, when they took their initial certification, when they took their last methods course, how many and what type of college science education courses were taken, and whether they felt they had adequate background or training in science. They were also asked if they felt confortable teaching science and if they were interested in improving their background in science or science education.

Grade Five Demography

A large number of teachers (517) answered the "Survey of Grade Five Teachers of Science". Of this group over 92 percent are now teaching grade five, and nearly 30 percent are also teaching grade six science. Nineteen percent are teaching grade four as well as grade five. These data reflect the multi-grade aspect of many of our elementary classrooms or the movement of the elementary teacher to other than home room classes.

When asked what grades of science they taught last year, 53 percent taught grade five science last year, 40 percent taught grade four and 45 percent grade six. A large number had also taught the primary grades' science and a smaller number grades 7-12 science.

Of the total group, over 80 percent are teaching at the grade level they prefer. Only 6 percent would like to be teaching at kindergarten to grade three levels and about 7 percent would like to be teaching junior or senior high school.

The majority of these grade five teachers took their most recent science education course in the last six years. The largest group took the course in 1976 and the next largest groups in 1978, 1979, and 1980. The median for most recent methods course was 1974-79.

A clear picture is revealed when the responses are considered to the question about how many college/university courses they have had in science. Sixty-three percent have had 1 - 3 courses in Biology and fifty percent have had 1 - 3 courses in Earth Science. The majority have had no courses in the other sciences. When asked about how many science education or methods courses they had taken, 24 percent have taken none, 53 percent one, with only 13 percent stating they had a major concentration in science education.

Despite the above data, 72 percent feel they have sufficient background/training to teach grade five science. Sixty-six percent say they are "comfortable" teaching science and 28 percent indicated "in-between".

In contrast to these statements 84 percent state they are interested in improving their background in science or science education. Several teachers in their added comments on the survey asked for more in-service training as well as science education courses.

Grade Eight Demography

A total of 309 grade eight teachers answered the survey instrument. Over 93 percent are teaching grade eight this year, 60 percent are also teaching grade seven and 44 percent teaching grade nine. A few are also teaching elementary science (17 percent) and a similar number secondary science.

The pattern of teaching for past years is diversified spread out with only 62 percent teaching grade eight last year, 64 percent teaching grade seven, and 45 percent teaching grade nine. Over 45 percent had taught elementary science but fewer had taught secondary science.

Of the grade eight teachers, 61 percent are teaching at the grade level they prefer, 13 percent would like to teach grades four to six science, and 20 percent would like to teach senior high science.

A large number of the teachers responding to the survey took their most recent science methods courses in the years from 1976-79, with the greatest number in 1976. This was the year the greatest number obtained their first certificates. Many teachers were also certified in the years 1970, 1968, and 1967. These data suggest that many grade eight teachers have been back for further training since certification.

When asked about their science course background, about 50 percent stated they had 1 - 3 courses in one or more of Biology, Chemistry, Physics and Earth Science. Only 34 percent had courses in Astronomy. Thirty-nine percent of the grade eight teachers did not have Physics. Biology and Chemistry were the disciplines in which a number of teachers had over 4 courses (24 percent and 22 percent respectively).

Courses in science education or methods had been taken by over 73% of the responding teachers. However, nearly 19 percent had no science education or methods course.

For the question asking if they, as a rule, are comfortable teaching science, over 80 percent stated "yes", 5 percent stated "no", and 15 percent indicated "in-between".

A few teachers, in their added comments, regretted the lack of unified in-services and workshops. In addition, there was a request for science content courses for teachers in rural areas.

Grade Eleven Demography

A total of 321 teachers responded to the grade eleven teacher survey. These teachers are teaching a broad range of courses this year with the largest proportion of them (41 percent) teaching Science 100. The next largest group (36 percent) is teaching Chemistry 200. From 20 - 30 percent are also teaching grade nine Science, Science 101, Physical Science 201, Physics 200, Physics 300, Chemistry 300, Biology 200, 201, and Biology 300, 301. (These percentages are of course not mutually exclusive.)

The picture is rather different for past years. Many had taught grade seven (27 percent), grade eight (30 percent) and grade nine (48 percent). The highest frequency of courses taught in senior high were Science 100 and Science 101. Very few have taught elementary science (10 percent).

If these teachers had a choice, 90 percent prefer teaching senior high science. Less than 2 percent prefer elementary or junior high science. Over 5 percent would prefer post secondary.

Many of the surveyed teachers took their most recent science education courses in 1978, 1972, 1973, 1974 and 1979. However, the largest number of grade eleven teachers got their first certificates in 1970, 1971, 1965, 1963, and 1967. Thus it appears that many of the teachers have taken science methods courses since their first certification.

When asked about their science course background, between 34 and 56 percent had 1 - 3 courses in one or more of Biology, Chemistry, Physics, or Earth Science. In contrast, over 64 percent had no course in Astronomy. Teachers had most courses in Biology, Chemistry, and Physics, least in Astronomy and Earth Science.

Most teachers (over 95 percent) had teacher education courses in science. Sixteen percent had one science methods course and 74 percent took a major concentration.

About 46 percent considered that the science education courses had been "adequate" or "very adequate". About 31 percent considered them "somewhat inadequate".

Over 93 percent stated that they were "comfortable" teaching science. This is in contrast to the responses of 66 percent for grade five teachers and 80 percent level for grade eight teachers.

IMPLEMENTATION OF DEPARTMENT OF EDUCATION GUIDES AND OTHER REFERENCE MATERIALS

The Department of Education has recently adopted science curriculum guides for grades kindergarten to six and grades seven to nine. The degree to which these guides have been implemented is indicated by the teachers responding to this survey.

Usefulness of Department of Education Guide

Most grade five teachers (82 percent) found the guide "useful", or "very useful". Only 3.2 percent of the 517 teacher respondents were unfamiliar with the guide. Indications are that over 77 percent of the 517 Manitoba grade five science teachers are implementing part or all of the recent guide. Seventy-eight percent of the grade five teachers said that "some" or "much" extra work was required to implement the new curriculum. Three percent felt that too much work was required to implement the new curriculum.

Eighty-eight percent of the 309 grade eight teachers indicated that the recent grades 7-9 Department of Education Curriculum Guide was "useful" or "very useful". Only two percent of the grade eight teachers were unfamiliar with the guide. Indications are that over eighty-five percent of the Manitoba grade eight science teachers are implementing some or all of the new curriculum. Eighty-five percent of the teachers reported that "some" or "much" extra work was required to implement the new curriculum. Two percent felt it was "too much" work to implement. Twenty-eight percent of the teachers felt they did not have enough time for students to achieve the objectives.

At the time of this survey no recent guide, at either the grade ten or grade eleven level, had been published. Fifty-two percent of the grade eleven teachers found the present guide to be "useful" or "very useful"

Science Reading Material Available

When asked; "How many DIFFERENT science magazines or books (not texts) are available to your student in your science area/room?" thirty-two percent of grade five teachers reported "none". Fifty-five percent of grade five teachers had from one to five books or magazines available to their students. Fifty percent of teachers felt that science reading materials in the school library was "satisfactory" or "very adequate".

The grade eight science teachers indicated that their science classrooms had from one to five different magazines or books available for reference in the classroom. Fifty-one percent of teachers felt that science reading materials in the school library was "satisfactory" or "very adequate".

Fifty-eight percent of the grade eleven teachers reported from one to five different science magazines or books available in classrooms for their students. Twenty-six percent reported "none". Sixty-four percent of teachers felt that science reading materials in the school library was "satisfactory" or "very adequate".

ELEMENTS WHICH FACILITATE INSTRUCTION

Class and Laboratory Assistance Given Teachers

Grade five teachers reported that they received some volunteer assistance from students (18 percent). Fifty percent received no assistance and thirty-one percent required no assistance. Science equipment in grade five is generally maintained by individual teachers (32 percent) or a designated teacher (32 percent). Twenty-six percent of the grade five teachers have no designated person to account for and maintain science equipment.

Eighteen percent of the grade eight teachers required no assistance, fourteen percent received volunteer assistance from students, and sixty-three percent received no assistance.

Nine percent of the grade eleven teachers required no assistance, twenty-nine percent received paid assistance from either adults or students. Fifty-five percent received volunteer assistance and five percent received no assistance.

Physical Facilities and Equipment for Teaching Science

More than fifty percent of the grade five teachers had thermometers, a globe, batteries, spring scales, hand lenses, magnets, plants, rocks, and a clock with a second hand in their classrooms. Only twenty-two percent of the classrooms have a hot plate, eleven percent a barometer, thirty-one percent a compass, twenty-seven percent an equal arm balance, thirty-eight percent live animals, thirty-four percent alcohol burners, forty-six percent candles, forty-eight percent seeds, forty-eight percent balloons, forty-one percent mirrors, forty-two percent flashlights, and thirty-five percent plasticene.

The grade five teachers consider their physical facilities to be adequate or better only in terms of lighting and audio-visual equipment. They rate their science equipment as "fair" in both quantity and variety.

Equipment is generally stored in a designated central storage room and not always convenient for the teacher. Fourteen percent reported the equipment to be generally scattered throughout the school. Grade five teachers report that the equipment is generally not organized in any specific manner.

Grade eight science teachers rate their physical facilities as adequate in terms of tables/counters, lighting, storage, audio-visual equipment and water and gas outlets. Locked metal storage space for volatiles and fume hoods were considered "very inadequate". The average rating of work space per student was just under "adequate".

The quantity and variety of science equipment available to the grade eight science teachers was considered to be fair to good. Twenty percent of the teachers considered the equipment to be "poor" or "very poor".

The grade eleven science teachers considered their science facilities to be adequate or better in all areas except plant and animal space, storage space for student projects, separate storage for acids, locked storage for volatiles, and fume hoods.

Ninety-one percent of the grade eleven teachers considered the quantity and variety of their science equipment to be "fair", "good" or "excellent".

Use and Availability of Textual and Supplementary Materials

Ninety-seven percent of the grade five teachers indicated that either the M.A.P.S. or S.T.E.M. program textbook materials were available for their use. Fifty-two percent supplemented their program with extra reading,forty-nine percent with extra content and seventy-five percent with extra activities.

Only fifty-six percent reported that the textual materials were available in sufficient quantity to teach their program. Forty-eight percent of the grade five teachers prefer the S.T.E.M. program, while only six percent prefer M.A.P.S. Seven percent prefer the "Science" by Houghton-Mifflin, twenty-three percent had no preference, and twelve percent specified other programs. The reasons for these preferences were nearly equally distributed among all choices The grade five teachers are most familiar with the S.T.E.M. program (69 percent). M.A.P.S. was second with eleven percent reported as the most familiar.

Teachers report that their students use S.T.E.M. and teacher developed units frequently. The teachers themselves use these same materials and the K-6 curriculum guide the most frequently. The K-6 curriculum guide was reported as the most frequently used teacher resource.

When asked to rate curriculum materials as to degree of usefulness, grade eight teachers reported the Focus on Science and Exploring Science Series to be the most useful, with the Lab Inquiry Text and Searching For Structure Series a close second. The Modular Activities Program in Science, Concepts and Challenge, I.I.S, and the Australian Science Education Project were considered less useful.

Although they are somewhat older materials, the Earth Science - A Laboratory Approach, the State I, II and III Exploring Science, Our Planet in Space and Physical Science - a Problem Solving Approach are considered to be of some use.

The grade eleven teachers were not asked to respond to the use and availability of textual materials.

INSTRUCTIONAL PRACTICES

Teachers at the three grade levels were asked to check the frequency that they engaged their students in certain listed instructional practices. Certain trends can be noted.

The trend is several instructional practices increased from grade five to grade eleven. Most noteworthy is "lecturing". It increased greatly from a frequency of "occasionally" in grade five to "often" in grade eleven. "Graphing using students' experimental data" also increased from less than "occasionally" at grade five, to "occasionally" at grade eleven. "Doing of worksheets" also increased markedly. "Doing problems at the end of a section in the book" increased from less than "occasionally" to "often" at grade eleven. "Carrying out experiments from a set of instructions" increased from "occasionally" to "more often". "Measuring in an experiment" increased notably from a frequency of "occasionally" at grade five to that of between "occasionally" and "often" by grade eleven.

Several instructional practices did not vary much in frequency between the grades. "Making up and carrying out their own experiments" was hardly ever done by students at these grade levels. "Discussing the possible errors in an experiment" was done occasionally at these grade levels. This also applies to a similar activity - "interpreting or explaining for themselves the results of an experiment". "Discussing results of an experiment with other students" was occasionally done at these grade levels. "Memorizing scientific information" was less than occasionally done at all grade levels with a slight increase at grade eight.

Some activities decreased at the grade eight level and then increased at grade eleven again. They were: applying information to new problem situations, and copying notes from the overhead or chalkboard. Both activities were done from "occasionally" to "frequently".

Many activities decreased in frequency from the grade five response to the grade eleven response. There was a marked decrease in doing the discrete science processes from "fairly often" to "occasionally" or less. These were: making guesses (inferring) about the results of an experiment, classifying objects or events, and describing observations in their own words. Other activities decreased in a similar fashion - doing investigations at home, reading from textbooks, and doing research in the library.

A separate question asked grade eight and eleven teachers what other than regular science classroom activities took place in their schools. For grade eight, 54 percent checked science fairs, 30 percent indicated science clubs, and 25 percent stated no other activities. Write-in comments for grades eight and eleven indicated a broad range of activities from field trips to 'Reach for the Top'. Grade eleven teachers indicated a lower frequency of science fair activities, (38 percent) recreation science clubs (38 percent), and 30 percent stated "none".

A fairly clear picture is revealed of the science classroom at various levels, and of the changing patterns of activity from level to level. A more teacher directed and controlled situation emerges by high school - lectures, experiments from worksheets, and problems at the end of chapters. The discrete basic processes of science decrease - observing, inferring, and classifying. Only one discrete process increases - measuring. Even after allowing for different interpretations of terminology, at all grade levels it seems that original and creative student thinking is not encouraged. There is little done in the areas of making up of students own experiments, doing an investigation at home, and library research. This data does not seem to reflect the picture of a student centered activity-oriented classroom. The grade five classroom shows more of this activity than any other level. Grade five students' most frequent activities were said to be:

- describing/reporting observations,
- making guesses about the results of an experiment, and
- interpreting or explaining for themselves the results of an experiment.

However, their next most frequent activity was reading from a textbook, followed closely by copying notes from a blackboard/overhead projector.

Added grade five teacher comments at the end of the questionnaire reflect a concern for what is going on in the classroom. Grade five teachers approve of the hands-on activity-based approach. They stated that the process approach is important because it develops the ability to think and find answers to problems. Some stated that their science programs suffered due to an emphasis on Language Arts. Many said they did not have enough time to plan, organize and arrange for science lessons.

Grade eight teachers expressed different viewpoints in their added comments. Several said that they had very little laboratory equipment or facilities and therefore were unable to teach adequately.

Multigrade classrooms were mentioned by many as contributing factors to the problems in teaching an adequate science program in grade five and grade eight classrooms.

Grade eleven teachers expressed a general concern regarding the need for a new general science course for Science 101. Also problems with small schools and related demands on the teacher were mentioned by several.

EVALUATION TECHNIQUES

Teachers in the three grade levels were asked to rate a list of evaluation procedures as to the emphasis they placed on the use of them in evaluating their students in science. The rating scale ranged from minimum to maximum emphasis.

"Teacher-made objective tests" were given a major emphasis at all three grade levels. "Work habits" was given highest rating for grade five, second highest for grade eight level and third rating for grade eleven. "Laboratory/experiment write-ups" were given second priority by grade eleven teachers.

Four aspects of evaluation which received some emphasis at grade five received decreasing emphasis through grade eight to minimal emphasis at grade eleven. They are:

work habits
general attitudes in class
projects
oral and written work

The only evaluation technique which increased from grade five to eight to eleven is "teacher-made objective tests".

Very low emphasis was given to "student self reports" at all levels. Also very low emphasis was allotted to "standardized objective tests", "oral tests", and "anecdotal records of achievements".

The two other evaluation methods listed - "individual work contracts", and "subjective tests" were given very low emphasis by all levels.

Additional comments as to other types of evaluation used were made by all levels of teachers. Notebooks and participation were popular aspects of evaluation by grade five teachers. Notebooks were also taken into account by grade eight teachers. Grade eleven teachers commented that exams were given major emphasis in their evaluation of students. Additional comments by individual teachers reflect personal styles, for example evaluating organization, neatness, discussion, ability, homework, and lab tests.

SAFETY

The availability of safety equipment varies greatly between the grade levels. Only 59 percent of the grade five science classrooms have fire extinguishers available whereas virtually all grade eight and eleven science classrooms do. Class sets of safety glasses are available only in 17 percent of grade five classes, 54 percent of grade eight and 79 percent of grade eleven classes. The availability of first aid kits varies between 50 percent and 60 percent for all grades. Fire blankets are very uncommon at grade five. Forty-eight percent of the science classrooms have them at grade eight level, and 68 percent at grade eleven.

Twenty-seven percent of grade five teachers report that they have no safety equipment. This decreases to 9 percent at grade eight and less than 1 percent at grade eleven.

Inspection of safety equipment is done infrequently at grade five and eight. At grade 11 the record is not good (never or less than once a year - 13 percent, and once a year - only 50 percent). The availability of other safety equipment such as safety gloves and continuous-flow eye wash stations was stated to occur in 16 percent and 34 percent respectively of the grade eight and eleven classrooms. The safety equipment situation in many Manitoba science classrooms appears to be low.

PRE-SERVICE AND IN-SERVICE SCIENCE TEACHER TRAINING

Teachers from the three grade levels responded to a question on pre-service and in-service training and the emphasis on certain aspects of this training.

Teachers stated that pre-service and in-service training for all grade levels in the study of "techniques of teaching science" is of "maximum importance". "Teaching practice" is very important at pre-service level (and of greater importance as the grade levels increase) but at in-service level it falls to less importance. "Lesson planning" follows a somewhat similar pattern - of major importance at pre-service time and becoming of minor importance for in-service training. However, lesson planning is of much greater importance to grade five teachers for both types of training than to teachers of any other grades.

At all grade levels "science content" was rated at the major emphasis level for pre-service training but fell slightly below for in-service. It is interesting to note that it is considered of lesser importance at grade eight level.

At all grade levels "survey of curriculum materials" maintains an almost equal importance for both pre- and in-service training.

"How to develop curriculum materials" is more important at the in-service than the pre-service level. It is noteworthy that for both types of training it is considered to be of lesser importance at the grade eleven level.

"Preparation of science materials" was rated consistently high for all grades and both categories.

"Testing and evaluation" is also of major importance at all grade levels and categories.

"Laboratory safety" is high in importance for all levels and categories, but is considered by grade five teachers slightly less important.

"Science as a way of thinking" is of moderate importance at pre-service level and drops for the in-service category.

"Discussion of problems in science teaching" is of major importance at the in-service level and slightly less than major importance at pre-service level. This difference is not unexpected, but it is noteworthy that the grade eight teachers for both categories consider this area to be of lesser importance than other grade level teachers.

"Care and maintenance of equipment" falls between major and minor emphasis for pre-service and in-service categories. It is considered to be more nearly major at the grade eight level.

"Psychology of learning" also falls between major and minor emphasis at pre-service, then drops to near minor importance for in-service training at all levels.

"Special education" and "history and philosophy of science" are considered to be of minor importance for both pre-service and in-service categories for all levels.

Additional comments added by the teachers supplement the above findings. Many grade five teachers stated that more in-service training was needed. They wish to know how to make science fun and enjoyable to teach. Others needed more help in doing activity-based science. Still others recommended certain Faculty of Education refresher courses in science. Some suggested courses in new science developments, designing experiments, the usefulness of science, and a study of the different levels of students' cognitive processes and ability to conceptualize. It was felt there was a need for further assistance in elementary science teaching.

Junior high teachers stated that science classes should be of high interest and should use many concrete materials. Some mentioned a lack of unified in-services and workshops. They also felt that professional development centers should be sharing information. Other suggested areas of emphasis were:

- how to teach individual concepts
- curriculum

- discipline in class and lab
- making of equipment
- classroom management and organization
- individualization
- adolescent behavior

Grade eleven teachers added some areas of emphasis in their supplementary comments. They applied equally to pre- or in-service sessions.

- followup and assistance to new teachers
- science and society
- discipline
- practical applications of science
- experimenting
- math and the science student

With respect to teacher pre-service and in-service training, then, teachers expressed a desire that an emphasis be placed on the following aspects of training:

1) Major emphasis at the pre-service level
    - teaching techniques
    - teaching practice
    - lesson planning
    - science content
    - survey of curriculum materials
    - preparation of science teaching materials
    - testing and evaluation
    - laboratory safety practices
2) Major emphasis at the in-service level
    - techniques for teaching science
    - survey of curricular materials
    - how to develop curricular materials
    - preparation of science materials
    - laboratory safety practices
    - testing and evaluation
    - discussion of common problems in science teaching
    - care and maintenance of science equipment and facilities

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The Science Assessment Program was intended to provide provincial data about the level of student achievement in Manitoba to those responsible for the educational system. This section summarizes findings regarding student achievement in science. Recommendations arising from a synthesis of the student achievement results and the teacher-survey data are also presented in this chapter.

STUDENT ACHIEVEMENT IN SCIENCE

Grade Five

Grade five student performance on knowledge and comprehension of science content was more than satisfactory, while performance on application of science content showed weaknesses in earth and space science.

Student performance was more than satisfactory on integrated processes and on higher cognitive level thinking. Performance was satisfactory on basic processes, nature of science, and safety.

There did not appear to be any appreciable differences between males and females on processes of science, a nature of science, or on higher cognitive level thinking in science. The differences were most pronounced in physical science.

Grade five students' attitudes and interests toward science were very positive.

Grade Eight

Grade eight student performance was satisfactory on knowledge and comprehension of science content, and on basic and integrated processes.

Performances was less than satisfactory on higher cognitive level thinking in science, nature of science, and safety. Student performance on application of science content showed weaknesses in earth and space science and in physical science.

Males outperformed females in earth and space science and in physical science, while females achieved higher on application of life science and on nature of science.

There was a tendency favoring males on higher cognitive level thinking while there was a similar tendency favoring females on basic processes. There was no appreciable difference on integrated processes.

Grade eight students' attitudes to, and interests in, science were marginally positive.

Grade Eleven

Student performance at the grade eleven level was more than satisfactory on nature of science and on application of science content. Performance was satisfactory on higher cognitive level thinking in science and on processes of science.

Student performance on safety and on laboratory technique was less than satisfactory, as was knowledge and comprehension of science content in most areas of science.

Males outperformed females in earth and space science and in physical science, with the exception of knowledge and comprehension of chemistry. Males outperformed females on higher cognitive level thinking and on processes. Females outperform males on application of life science and on the nature of science.

Grade eleven students' attitudes and interests toward science were marginally positive.

GENERAL RECOMMENDATIONS

General recommendations arising from a synthesis of the student assessment results and the teacher survey data are presented below.

In the area of processes of science

1. That all teachers of science should enhance their classroom activities with a variety of process-centered student activities. The basic processes, as well as many of the integrated ones, can and should be an integral part of most activities in science.
2. That the act of experimenting, including hypothesizing and identifying variables, should be explicitly practiced at the elementary and junior high levels.
3. That a conscious effort be made by teachers at all grade levels to teach the methods and the quantitative skills of measurement. This may be done by seeking ways and means of including an element of measurement as an associated portion of most activities in science.

In the area of the nature of science

1. That every teacher of science should make a deliberate attempt to relate the logical thinking processes involved in science to the students' everyday activities.
2. That level three curriculum materials be developed to assist elementary, junior, and senior high teachers in the teaching of the nature of science.

In the area of safety

1. That specific safety classes be conducted in all areas of science at all grade levels to teach students appropriate techniques and procedures. These procedures should be practised as a part of the normal classroom routine.
2. That school administrators assure that a regular safety inspection program for facilities, equipment adequacy and functionality be established for all classrooms where science is taught.
3. That all schools make every effort to remedy deficiencies regarding locked metal storage space for volatile substances, fume hoods or ventilation equipment, and storage space for animals, plants, and student projects. This problem applies to both junior and senior high levels.

In the area of observed sex differences in science

1. That all educators make sure that their efforts do as much as possible to allow all students to achieve to their potential regardless of the subject matter. All educators should be aware of a possible sexist bias in curriculum, in textual materials, in classroom management practices, and in the instructors own attitudes, and should develop teaching strategies to combat it.
2. That school divisions seek to provide effective role-models in science for both sexes at all grade levels; in particular that female teachers of science be encouraged by school administrators and by their colleagues to become more active in the area of science curriculum development, assessment programs, and the overall teaching and administration of science activities.
3. That all educators attempt to further identify reasons for the observed sex differences in science achievement and attitude.

In the area of attitudes toward science

1. That educators investigate further the trends suggested by responses to the attitude items in the assessment instrument.

In the area of teacher training and inservice

1. That teachers be assisted in becoming familiarized with alternative teaching strategies in K-6 and 7-9 science, in particular with ways and means of shifting from teacher-centered to more student-centered classrooms.
2. That teachers receive assistance in developing both formal and informal classroom evaluation methods.
3. That teachers receive assistance regarding developing and managing multi-grade science classrooms. This problem is acute in small schools at all grade levels.

In the area of reading material and science equipment

1. That schools address the need to purchase sufficient quantities of textual and other reading material to allow teachers to adequately teach their science programs. This need is most acute at the elementary level.
2. That the Department of Education develop guidelines for the purchase, storage, and management of equipment, materials, plants, and animals in elementary schools.

In the area of curriculum development and implementation

1. That assistance be given teachers by school divisions to further the implementation of the new science curriculum.
2. That school divisions coordinate and establish facilities which will accommodate the sharing and dissemination of science curricular materials, equipment, resources, and personnel, K-12.

3. That support documents (level III) be developed for added teacher support in the areas of low student achievement across the grades, e.g., metric measurement, processes in science, and safe techniques and procedures. Additional topical areas that could be considered are graphing, weathering and erosion, the terminology of the physical sciences, electricity, molecular theory, weather and climate, work-energy relationships, photosynthesis, and plant growth.
4. That consideration be given to adding earth and space science to the high school program, possibly by integrating earth and space science into physics, chemistry, and physical science.
5. That teachers analyze their own programs in light of the following specific areas of concern regarding student performance.

Grade Five Earth and Space Science

- Use of Celsius thermometers.
- Practical activities in earth science.
- Differentiation between terms such as weathering and erosion.

Grade Five Physical Science

- Nature of sound, heat, and electricity.
- Hands-on activities and experiences in physical science.
- Vocabulary of physical science.

Grade Five Processes - Basic

- Rounding in linear measurement.
- The difference between observing and inferring.

Grade Five Processes - Integrated

- Identification of variables, hypothesizing, and experimenting.
- Interpolation and extrapolation as part of the prediction process.

Grade Eight Earth and Space Science

- Earth science (e.g., weathering versus erosion, soils).
- Aspects of weather such as dew, evaporation.
- Hands-on activities.
- Application and higher cognitive level thinking.

Grade Eight Physical Science

- Terminology of the physical sciences.
- Facts associated with light, electricity, molecular theory, chemical change.
- Application and higher cognitive level thinking (as for earth science).
- SI measurement.
- Methods and skills of measurement such as rounding off and error in linear measurement, volume measurement by liquid displacement.

Grade Eight Processes - Integrated

- . Experimenting (as a variable by variable test for cause and effect) including hypothesizing and controlling variables.

Grade Eleven Earth and Space Science

- . Astronomy, earth science, weather, and climate. (The new curriculum recognizes this emphasis.)

Grade Eleven Physical Science

- . Application of the concepts and facts taught, perhaps with more testing of simple situations requiring students to apply concepts.

Grade Eleven Life Science

- . Aspects of biology that are relevant to the every day life and experience of students.
- . Human biology. (The new curriculum recognizes this emphasis.)
- . Natural history including the study of plants.

Grade Eleven - Processes of Science

- . Measurement, for example linear measurement with error estimation and volume measurement by liquid displacement.

Appendix 1

COMPARISONS FOR ALL CROSS GRADE ITEMS

AREA	ITEM NO. Gr. 5	ITEM NO. Gr. 8	ITEM NO. Gr. 11	PERCENT CORRECT Gr. 5	PERCENT CORRECT Gr. 8	PERCENT CORRECT Gr. 11
Earth and Space	25	8		48	79	
	26	9		65	81	
	27	7		36	50	
	28	4		45	69	
	31	5	3	38	31	54
	33	2	1	38	53	74
	35	21	15	23	40	71
	37	17		19	40	
		23	18		45	58
Physical Science	39	26		48	50	
	43	24		36	38	
	54	44		44	76	
		30	30		34	39
		37	43		62	76
		39	45		48	61
Life Science	58	68		73	85	
	59	70	116	15	34	43
	60	67		56	64	
	63	91	112	62	70	74
	69	62		60	73	
		63	109		27	32
		72	96		74	82
		58	101		47	49
		56	104		43	60
		69	97		41	43
		61	108		31	[illegible]
		66	107		73	70
Nature of Science	7	100		40	68	
	8	101		43	46	
	9	102		67	68	
	21	76	53	63	67	90
Safety	10	96		69	60	
	11	99		55	59	
Process of Science	12	79		66	73	
	67	92		46	56	
		90	60		54	82
		77	49		66	81

SURVEY OF GRADE 5 TEACHERS OF SCIENCE

Please check all items once only unless otherwise instructed.

1. Which science courses have you taught and are you teaching? (Check more than one if appropriate).

	This Year	Past Years
1) Kindergarten	0.6 %	2.7 %
2) Grade/Year 1	3.1	12.8
3) Grade/Year 2	3.9	16.2
4) Grade/Year 3	6.6	24.2
5) Grade/Year 4	19.0	39.5
6) Grade/Year 5	92.5	52.6
7) Grade/Year 6	29.2	44.5
8) Science 7	6.6	21.9
9) Science 8	5.6	15.9
10) Science 9	1.7	7.5
11) Science 10	0.0	2.7
12) Biology (high school)	0.2	1.4
13) Physics (high school)	0.0	1.2
14) Chemistry (high school)	0.0	1.2
15) Other (specify) ______	0.2	1.5

2. How many hours a week are you actually teaching science at present?

1) none	1.0 %
2) one half-hour or less	1.0
3) 1 hour	10.0
4) 2 - 3 hours	64.7
5) 4 - 5 hours	11.4
6) 6 or more hours	12.0
med.	4.1

3. To how many different classes are you presently teaching science?

1) none (another teacher takes my class)	2.9 %
2) my own class only	63.9
3) two to three different classes	27.0
4) four or more different classes	6.3

4. How many students are in your Grade 5 science class(es) this year?

	Largest	Average (or one class only)	Smallest
1) 20 or less	35.5 %	32.0 %	36.4 %
2) 21 - 24	22.9	24.0	30.3
3) 25 - 28	24.8	30.6	19.2
4) 29 - 32	13.6	12.3	14.1
5) over 32	3.3	1.1	0.0
med.	2.1	2.25	1.95

5A. What kind of assistance are you given for teaching Grade 5 science, for example for cleaning up after science lessons, for preparing new lessons, for maintaining science equipment, etc.?

1) no assistance required	31.0 %
2) paid adult assistance	0.6
3) paid student assistance	0.0
4) volunteer assistance from parents	0.0
5) volunteer assistance from students	18.3
6) no assistance	50.1

5B. Who maintains and accounts for the science equipment in your school?

1) each teacher looks after his/her own equipment	32.0 %
2) each teacher looks after certain equipment	4.5
3) a specially designated teacher or head of science department	32.2
4) paid assistants	0.2
5) no designated person	26.0
6) no equipment is used	0.4
7) other (specify) ______	4.7

6. What emphasis do you place on each of the following for your formal evaluation of Grade 5 students in science? (Write in the appropriate number from the scale below).

1	2	3	4	5
Minimum Emphasis	Minor Emphasis	Major Emphasis	Maximum Emphasis	Does not apply

	Median
1) teacher-made objective tests	2.9
2) standardized objective tests	1.7
3) subjective tests (essays, paragraphs, etc.)	1.9
4) laboratory/experiment write-ups	2.2
5) individual work contracts	1.9
6) oral and written reports	2.3
7) projects (eg. for display)	2.4
8) oral tests	1.7
9) student self reports	1.6
10) anecdotal records of achievement	1.8
11) general attitude in class	2.8
12) work habits	2.9
13) other (specify)	2.8

7. How often do you engage the students in your Grade 5 science classes in each of the following activities? (Write in the appropriate number from the scale below).

1	2	3	4	5
Hardly Ever	Occasionally	Often	Frequently	Very Frequently
(0,1 or 2 times during course)	(one out of four science class periods)	(every other period)	(3 out of 4 science class periods)	(almost every science class period)

1) carrying out experiments from a set of instructions	2.1
2) making up and carrying out their own experiments	1.3
3) discussing the possible errors in an experiment that has been completed	2.2
4) listening to lectures	2.1
5) making a graph from the data that the students get from an experiment	1.7
6) applying information to new problem situations	2.3
7) making guesses about the results of an experiment	2.4
8) interpreting or explaining for themselves the results of an experiment	2.4
9) classifying objects or events	2.3
10) describing/reporting observations in their own words	2.7
11) measuring in an experiment	2.1
12) doing worksheets	1.7
13) discussing results of an experiment with other students	2.1
14) copying notes from the blackboard/overhead projector	2.2
15) working on problems at the end of a section in a book	1.8
16) memorizing scientific information	1.6
17) doing investigations at home	1.5
18) reading from textbooks	2.3
19) doing research in the library	2.0

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8. How would each of the following changes be likely to affect the quality of science learning in your Grade 5 classroom? (Write in the appropriate number).

KEY: The quality of learning would likely:

1	2	3	4	5
Deteriorate Greatly	Deteriorate Somewhat	Remain The Same	Improve Somewhat	Improve Greatly

1) more direct input by you into the purchase of median equipment.	3.4
2) better quality of equipment.	3.7
3) more assistance for maintenance of equipment	3.4
4) smaller class size	3.8
5) provision of wider selection of printed materials (texts).	3.9
6) more leadership and coordination at school level	3.4
7) more leadership coordination at division /district level.	3.4
8) decreased emphasis on core	3.0
9) increased provision of in-service.	3.8
10) more science books in the library.	3.9
11) more time for preparation and marking.	4.2
12) more convenient storage space for equipment.	3.6
13) more university courses in science (taken by yourself).	3.7
14) higher priority placed on science by administration	3.3
15) more time allocated to science	3.5
16) complete revision of K-6 science program	3.0
17) few subjects/levels to teach	3.8

9. In your opinion, what three changes from the above list would most improve the quality of science learning in your Grade 5 classroom?

Rank	Item (write in number from above list)
1 (highest)	4
2	11
3	5

10. Which of the new science textbook materials are available for use in your class? (Check all that apply)

1) M.A.P.S. (Houghton-Mifflin).	56.1%
2) S.T.E.M. (Addison Wesley).	41.0
3) Science 5/13 (MacDonald)	1.8
4) Science (Houghton-Mifflin)	1.0
5) E.S.S. (McGraw-Hill)	0.0
6) I don't know	0.0
7) Other (specify).	0.0

11A. how do you supplement the elementary science program selected for your grade level? (Check all that apply).

1) no opportunity to supplement	6.0%
2) no need to supplement.	4.0
3) extra reading.	52.0
4) extra content.	49.0
5) extra activities (eg., field trips, speakers, films)	75.0
6) other (specify).	7.0

11B. To what extent did you teach the new elementary science curriculum last year?

1) only old curriculum	7.1%
2) majority old, some new curriculum.	18.9
3) some old, majority new curriculum.	23.9
4) only new curriculum.	34.3
5) I did not teach science last year.	15.8

12. Are sufficient textbook materials available to your classroom for teaching the selected program to your grade 5 class?

1) sufficient materials are available.	56.1%
2) insufficient materials are available.	41.0
3) no materials are available.	1.8
4) I don't know.	1.0

13. Has implementing the new curriculum meant extra work for you?

1) too much extra work to implement	2.8
2) much extra work was required.	27.8
3) some extra work was required.	50.0
4) extra work was not required	12.4
5) have not tried to implement	7.0

If you have checked 1, 2 or 3 above, what extra work was required? ______________________________

14. Which of the five authorized programs do you prefer for your grade 5 science class? (Check only one).

1) M.A.P.S (Houghton-Mifflin).	5.8
2) S.T.E.M. (Addison Wesley)	48.1
3) Science 5/13 (MacDonald).	1.8
4) Science (Houghton-Mifflin).	6.9
5) E.S.S. (McGraw-Hill).	1.3
6) I don't know.	23.4
7) Other (specify) ____________	12.7

15. Why do you prefer the program specified in the above question? (If you did not select a program go on to the next question). Check all that apply.

1) materials readily available	29.0
2) more readable	32.7
3) more relevant to students	32.9
4) easier to teach	20.7
5) easier to prepare	17.4
6) better teacher's guide.	25.1
7) better balance between content and process.	27.3
8) right amount on activity.	27.3
9) right degree of structure	18.0
10) suited to my background	16.4
11) other (specify)____________	5.0

16. Which one of the new programs are you most familiar with? (Check only one).

1) M.A.P.S. (Houghton-Mifflin)	11.0
2) S.T.E.M. (Addison Wesley)	68.5
3) Science 5/13 (Macdonald).	1.4
4) Science (Houghton-Mifflin).	5.8
5) E.S.S. (McGraw-Hill).	1.4
6) I don't know.	6.8
7) Other (specify) ____________	5.1

17. How often do you or your students actually use the following?(Write in the appropriate number).

1	2	3	4	5
Never	Rarely	Sometimes	Frequently	Does not apply

	Myself	Students	
1) M.A.P.S. text or resource books	2.5	1.4	Median
2) S.T.E.M. text or resource books	3.8	3.5	
3) Science 5/13 teacher resource books	1.3	1.1	
4) "Science" Text or resource books.	3.1	2.5	
5) E.S.S. teacher resource text.	1.2	1.1	
6) Elementary (K-6) Science Curriculum Guide.	3.8	1.2	
7) Locally-developed units	1.4	1.4	
8) Teacher-developed units	3.2	3.0	
9) Other (specify) ____________	3.1	3.1	

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18. Which of the following items do you or have you had in your Grade 5 science classroom at some time this school year? (Check all that apply).

	HAVE HAD
1) live animals	37.7 %
2) thermometers	59.4
3) globe	83.4
4) batteries	51.5
5) equal arm or pegboard balances	26.7
6) spring scales	50.5
7) hand lenses	55.9
8) magnets	54.7
9) magnetic compasses	30.9
10) plasticene	35.2
11) flashlights	42.0
12) mirrors	40.8
13) balloons	47.8
14) plants	59.6
15) seeds	47.8
16) candles	45.8
17) rocks	61.7
18) barometer	10.6
19) alcohol burners	34.2
20) hot plate	22.1
21) clock with second hand	56.7

19. How adequate are the following physical facilities for teaching science in your school? (Please write the appropriate number).

SCALE

1	2	3	4	5
Very Inadequate	Inadequate	Adequate	Very Adequate	Does not apply

	Median
1) tables/counters	2.7
2) lighting	3.3
3) storage space for science materials/equipment	2.6
4) amount of work space per student	2.6
5) plant/animal space	2.2
6) preparation room	2.1
7) storage/display space for student projects	2.0
8) audio-visual equipment	3.1
9) gas outlets	1.3
10) water outlets	2.5
11) electrical outlets	2.8
12) sink or drainage facilities	2.4

20. Overall, how do you rate the quantity and variety of the science equipment available to you?

	Quantity	Variety
1) very poor	8.6	6.6 %
2) poor	15.1	15.6
3) fair	38.0	40.0
4) good	32.9	31.4
5) excellent	5.4	6.4

21. Where is most of the equipment used for conducting science-related activities with students stored in your school?

1) convenient central storage room	34.3
2) inconvenient central storage room	21.8
3) scattered throughout the school	14.1
4) designated classroom	25.3
5) no equipment is used	0.7
6) other (specify)____________	4.0

22. Equipment used for conducting science-related activities with students is organized on the basis of:

1) kits containing materials for each unit	6.1 %
2) an alphabetical listing of commonly used materials	10.8
3) a combination of the above	21.7
4) no equipment is used	1.1
5) the equipment is not organized	53.6
6) other (please specify)____________	6.8

23. Which of the following safety equipment do you have available for use for teaching Grade 5 science? (Check all that apply).

1) safety glasses	14.9
2) fire extinguisher	58.8
3) fire blanket	6.4
4) first aid kit	58.8
5) other (specify)____________	3.9

24. How frequently is the safety equipment checked in your science area/room/laboratory?

1) never	10.9
2) less than once a year	10.2
3) once a year	35.9
4) more than once a year	15.7
5) I have no safety equipment	27.3

25. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your Grade 5 students in your science area/room/laboratory?

1) none	32.4
2) 1 - 5	55.4
3) 6 - 10	5.1
4) 11 - 15	1.2
5) more than 15	5.9

26. In your opinion how adequate are the science reading materials for Grade 5 students in your school library?

1) there is no school library	3.6
2) very inadequate	10.6
3) somewhat inadequate	33.7
4) satisfactory	39.5
5) very adequate	11.2
6) unfamiliar with materials	1.4

27. In your opinion, how useful is the approved Manitoba Department of Education curriculum guide for the science program you are presently teaching?

1) of no use	0.8
2) of little use	14.0
3) useful	59.0
4) very useful	23.0
5) unfamiliar with guide	3.2

28. If you had a choice, at which grade level would you prefer to teach science?

1) primary/kindergarten (K-3)	6.0
2) intermediate (4-6)	80.2
3) junior high (7-9)	4.4
4) senior high (10-12)	1.[illegible]
5) post secondary	0.[illegible]
6) none	7.5

29. As a rule, are you comfortable teaching science?

1) yes	65.4
2) no	6.8
3) in-between	27.8

30. On the average, how many minutes a week (5 days) do your grade 5 students take science at present?

1) less than 30 minutes	0.2
2) 30 - 59 mins.	6.5
3) 60 - 119 mins.	28.7
4) 120 - 179 mins.	43.4
5) 180 - 239 mins.	18.8
6) 240 - 299 mins.	1.8
7) 300 - 359 mins.	0.6
8) 366 or more minutes	0.0

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31. How important do you think elementary science (K-6) should be in a child's elementary schooling?

1) less important than all other subjects.	1.2 %
2) less important than most other subjects	24.
3) equal to other subjects	70.
4) more important than most other subjects	3.4
5) more important than all other subjects.	0.0

32. How many courses in science education or methods have you taken?

1) none.	23.8
2) one	52.8
3) major/concentration in science education.	12.7
4) other (specify)________________	10.7

33. When did you take your MOST RECENT science education or methods course?

19 76, 78, 79 (Median 1974-9)

34. How many college/university courses (academic or content courses) have you had in each of the following areas of science?

	0	1-3	4-7	8 or more
1) Biology	30.2	62.2	5.7	2.0
2) Chemistry	62.6	30.5	6.6	0.3
3) Physics	69.6	29.0	1.4	0.0
4) Astronomy	74.3	24.9	0.8	0.0
5) Earth Science	40.9	49.6	6.7	2.9
6) Other (specify)____________	60.0	30.0	6.4	3.6

35. Do you feel you have had sufficient training/background to teach Grade 5 science?

1) no.	28.0
2) yes	72.0

36. Are you interested in improving your background in science or science education?

1) no.	16.0
2) yes	84.0

37. How much emphasis SHOULD be placed on each of the following in preparing teachers to teach Grade 5 science? (Write in the appropriate number).

1 Minimum Emphasis	2 Minor Emphasis	3 Major Emphasis	4 Maximum Emphasis	5 Does not apply

	PRESERVICE	INSERVICE	
1) science as a way of thinking. . .	2.9	2.8	Median
2) techniques of teaching science. .	3.4	3.3	
3) science content	3.0	2.9	
4) history and philosophy of science	1.8	1.5	
5) psychology of learning.	2.5	2.1	
6) testing and evaluation in science	2.9	2.9	
7) survey of available curriculum materials	2.9	2.9	
8) how to develop curriculum materials	2.9	3.0	
9) lesson planning	3.2	2.8	
10) preparation of science materials.	3.0	3.0	
11) practice in teaching science. . .	3.2	2.7	
12) discussion of problems of science teaching.	2.8	3.0	
13) care and maintenance of equipment	2.5	2.4	
14) laboratory safety	3.1	2.9	
15) special education	2.2	2.2	
16) other (specify)______________	2.5	2.6	

38. In your opinion, what three areas from the above list would assist most in preparing teachers to teach Grade 5 science?

Rank	Preservice	Inservice
	(Write in number from preceding list)	
1 (highest).	2, 3, 1	2, 7, 8
2	2, 9, 11	6, 2, 8
3	6, 11, 9	12, 6, 10

39. Rank the following purposes of elementary science programs from most important (Rank 1) to least important (Rank 8)
Elementary science programs should help students to:

	RANK Median
1) review and develop skills and concepts that support other areas of study such as mathematics or social studies	5.9
2) develop an understanding of science content and concepts	4.6
3) develop skills of social interaction	6.1
4) develop skills in science processes such as observation, classification, inference	3.1
5) develop attitudes such as curiosity, objectivity, accuracy	2.3
6) develop positive attitudes towards their physical environment.	3.4
7) develop manipulative skills which are needed for the use of simple materials and apparatus. . . .	6.0
8) develop an interest in science	3.4

40. Do you have any other comments?
Please write your comments here.

THANK YOU FOR YOUR ASSISTANCE.

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SURVEY OF GRADE 8 TEACHERS OF SCIENCE

Please check all items once only unless otherwise instructed.

1. Which science courses have you taught and are you teaching? (Check more than one if appropriate).

	This Year	Past Years
1) Elementary science (K-3)	2.9	9.7 %
2) Elementary science (4-6)	14.6	35.9
3) Science 7	59.2	63.4
4) Science 8	93.9	61.5
5) Science 9	43.7	44.7
6) Science 100	5.8	12.6
7) Science 101	3.6	11.7
8) Science 103	1.3	1.6
9) Science 203	0.3	1.3
10) Science 303	0.0	0.6
11) Physical Science 201	2.6	6.8
12) Physical Science 301	1.3	4.9
13) Physics 200	0.6	7.1
14) Physics 300	0.6	5.5
15) Chemistry 200	2.9	11.3
16) Chemistry 300	2.6	9.1
17) Biology 200, 201	3.9	8.7
18) Biology 300, 301	3.9	7.4
19) Other (specify)________	3.2	2.9

2. How much of your teaching time do you spend as a science teacher?

1) full-time science	21.6
2) part-time science	2.0
3) part-time science, part-time in one other subject area	27.2
4) part-time science, part-time in two or more other subject areas	47.2
5) part-time science, part-time counselling and/or administration	2.0

3. How many students are in your Grade 8 science class(es) this year?

	Largest	Average (or one class only)	Smallest
1) 20 or less	20.6	32.2	43.6
2) 21 - 24	17.8	26.8	28.9
3) 25 - 28	31.7	26.1	22.1
4) 29 - 32	20.0	11.5	4.7
5) over 32	10.0	3.4	0.7
	med 2.9	med 2.2	med 1.7

4. What kind of assistance are you given for teaching Grade 8 science, for example for cleaning up after science lessons, for preparing new lessons, for maintaining science equipment, etc.?

1) no assistance required	18.2
2) paid adult assistance	3.1
3) paid student assistance	0.3
4) volunteer assistance from parents	0.7
5) volunteer assistance from students	14.4
6) no assistance	63.4

5. How many hours per week, on the average, do you spend to prepare and mark for your science classes?

1) less than 1 hour	3.3
2) 1 - 2 hours	19.2
3) 3 - 4 hours	33.2
4) 5 - 6 hours	15.6
5) more than 6 hours	28.7
med	3.3

6. On the average, how many times do you assign work to be done out of class to each Grade 8 science student in a week?

1) 0	11.2
2) 1 or 2 times	71.0
3) 3 or 4 times	15.8
4) 5	1.3
5) 6 or more	0.7
med	2.0

7. What emphasis do you place on each of the following for your formal evaluation of Grade 8 students in science? (Write in the appropriate number from the scale below).

1	2	3	4	5
Minimum Emphasis	Minor Emphasis	Major Emphasis	Maximum Emphasis	Does not apply

	median
1) teacher-made objective tests	3.1
2) standardized objective tests	1.2
3) subjective tests (essays, paragraphs, etc.)	2.0
4) laboratory/experiment write-ups	2.4
5) individual work contracts	1.8
6) oral and written reports	1.9
7) projects (eg. for display)	2.1
8) oral tests	1.3
9) student self reports	1.2
10) anecdotal records of achievement	1.4
11) general attitude in class	2.2
12) work habits	2.5
13) other (specify)________	2.8

8. How often do you engage the students in your Grade 8 science classes in each of the following activities? (Write in the appropriate number from the scale below).

1	2	3	4	5
Hardly Ever	Occasionally	Often	Frequently	Very Frequently
(0, 1 or 2 times during course)	(one out of four science class periods)	(every other period)	(3 out of 4 science class periods)	(almost every science class period)

	Median
1) carrying out experiments from a set of instructions	2.2
2) making up and carrying out their own experiments.	1.2
3) discussing the possible errors in an experiment that has been completed	2.2
4) listening to lectures	2.5
5) making a graph from the data that the students get from an experiment.	1.9
6) applying information to new problem situations.	2.2
7) making guesses about the results of an experiment	2.2
8) interpreting or explaining for themselves the results of an experiment.	2.3
9) classifying objects or events	1.9
10) describing/reporting observations in their own words	2.5
11) measuring in an experiment.	2.3
12) doing worksheets.	2.1
13) discussing results of an experiment with other students.	1.9
14) copying notes from the blackboard/overhead projector	2.2
15) working on problems at the end of a section in a book.	2.0
16) memorizing scientific information	1.8
17) doing investigations at home.	1.2
18) reading from textbooks.	2.2
19) doing research in the library.	1.7

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9. Which of the following science activities take place in your school? (Check all that apply).

1) recreation science (either in school or extra-curricular clubs - lapidary, science, photography, nature study). 30.1%
2) science fair 53.7
3) other (specify)__________ 5.5
4) none 24.9

10. Which organization of school year does your school have?

1) trimester. 2.0
2) semester 12.4
3) regular full year. 84.6
4) other (specify)__________ 1.0
med 2.9

11. Do you have enough time to achieve your objectives with your science students?

1) more than enough time. 1.7
2) enough time. 37.9
3) almost enough time 31.9
4) not enough time. 28.6
med 2.8

12A. About what percent of total science time is usually spent by your classes on each of the following sections of Grade 8 science?

	Percent of Total Science Time:					
	0-9	10-19	20-29	30-39	40-49	50+
Environmental Science	9.4	61.4	21.7	4.9	1.1	1.5
Life Science	2.9	57.4	29.0	8.1	1.5	1.1
Earth Science	6.7	63.0	25.6	2.6	1.1	1.1
Space Science	14.3	67.8	14.7	1.9	0.4	0.8
Physics	9.7	67.6	19.8	2.0	0.4	0.4
Chemistry	10.5	68.0	18.2	2.8	0.0	0.4
Have not Taught Grade 8	64.3	21.4	7.1	0.0	0.0	7.1

12B. On the average, how many minutes a week (5 days) do your Grade 8 science students receive science instruction at present:

1) less than 100 minutes. 3.0
2) 100 - 199 mins. 40.7
3) 200 - 299 mins. 50.7
4) 300 - 399 mins. 3.6
5) 400 - 499 mins. 1.3
6) 500 - 599 mins. 0.3
7) 600 - 699 mins. 0.3
8) 700 - 799 mins. 0.0
9) 800 or more mins. 0.0
10) I do not teach Grade 8 science at present. 0.0

13. How useful do you find the following materials for teaching Grade 8 science? (Write the appropriate number).

1	2	3	4	5
Of no use	Of Little Use	Useful	Very Useful	Can not say

Median

1) Earth Science: A Laboratory Approach 2.5
2) Exploring Science: Thurber & Kilburn
   Stage I. 2.3
   Stage II 2.5
   Stage III. 2.2
3) Interaction of Man and the Biosphere: Abrahamson et. al. 1.9
4) Life in the Environment-1973 edition 2.2
5) Our Planet in Space - The Earth Sciences . . 2.7
6) Physical Science: A Problem Solving Approach 2.6
7) Australian Science Education Project: (specify) 1.4
8) Exploring Science Series. 2.9
   Exploring Life Science
   The Environment 2.8
   The Human Body 3.0
   Exploring Earth Science
   Geology. 3.0
   Earth's Surface. 2.9
   The Atmosphere 2.9
   Astronomy. 2.9
   Exploring Physical Science
   Chemistry. 2.6
   Balanced and Unbalanced Forces 2.2
   Heat, Sound and Light. 2.9
   Electricity. 2.7
   Energy 2.8
9) Focus on Science: Heimier and Lockard . . . 3.5
   Life Science Modules:
   Animals and Plants 3.5
   Microbes and Disease 3.6
   Human Biology. 3.7
   Reproduction and Heredity. 3.2
   Physical Science Modules:
   Properties of Matter 3.1
   Changes in Matter. 3.2
   Measurement and Motion 3.0
   Heat, Light and Sound. 3.1
   Earth Science Modules:
   Erosion. 3.3
   Earth's Matter and Origin. 3.0
   The Atmosphere and the Hydrosphere 2.9
10) Lab-Inquiry Texts: Physical Science:
   Behaviour of Light and Sound 2.6
   Force and Motion 2.8
   Measurement. 2.8
   Methods of Science 2.7
   Work, Energy and Simple Machines 2.8
11) Modular Activities Program in Science:
   Soil, Sea and Sky. 2.2
   Continuity of Life 1.9
   Matter, Force and Motion 2.0
   The Physical World 1.8
12) Searching For Structure Series:
   Life Science:
   Microbiology 2.7
   Ecology. 2.6
   Environmental Science. 2.4
   Physical Sciences:
   Solids, Liquids and Gases. 3.1
   Structure of Matter. 2.9
   Heat and Electric Energy 2.9
   Earth Science:
   Rocks, Minerals and Fossils. 2.8
   Weather and Climate. 2.7
13) Earth Science: A Search for Understanding . 1.9
14) Exploring Physical Science: Thurber 2.7
15) Focus on Earth Science: Heimier and Lockard 3.3
16) Focus on Physical Sciences: Heimier and Lockard. 3.3
17) Focus on Life Science: Heimier and Lockard. 3.5
18) Life Science: A Problem Solving Approach. . 2.8
19) Concepts and Challenges in Science Book 1. . 2.6
20) I.I.S. Life Science: Part One. 1.4
21) Pathways in Science - metric: (specify)__________ 2.6

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14. How adequate are the following physical facilities for teaching science in your school? (Please write the appropriate number from the following scale).

1	2	3	4	5
Very Inadequate	Inadequate	Adequate	Very Adequate	Does not apply

	median
1) tables/counters	3.0
2) lighting	3.3
3) storage space for science materials/ equipment	2.9
4) amount of work space per student	2.8
5) plant/animal space	2.1
6) preparation room	2.5
7) storage/display space for student projects	2.1
8) audio-visual equipment	3.1
9) gas outlets	2.7
10) water outlets	2.9
11) eletrical outlets	2.9
12) sink or drainage facilities	2.8
13) separate storage space for acids	2.3
14) locked metal storage space for volatiles	1.6
15) fume hood/closet	1.5

15. What safety equipment do you have available for use for teaching Grade 8 science? (Check all that apply)

1) fire blanket(s) - asbestos type	23.9%
2) fire blanket(s) - other types	24.6
3) fire extinguisher(s) - ABC type	70.6
4) fire extinguisher(s) - AB type	15.2
5) fire extinguisher(s) - other type (specify) ______________________	8.7
6) master gas shut-off	52.8
7) master electrical shut-off	21.7
8) approved first aid kit	51.5
9) safety goggles, sufficient for whole class	53.7
10) master water shut-off	20.1
11) safety gloves	16.2
12) sand buckets and scoops	5.8
13) continuous flow eye wash stations	17.2
14) other (specify)______________________	7.1
15) none of the above	6.1

16. How frequently is the safety equipment checked in your science area/room/laboratory?

1) never	5.6
2) less than once a year	18.4
3) once a year	44.4
4) more than once a year	22.6
5) I have no safety equipment	9.0

17. Overall, how do you rate the quantity and variety of the science equipment available to you.

	Quantity	Variety
1) very poor	8.6	8.0
2) poor	11.3	12.0
3) fair	36.6	33.8
4) good	38.0	40.7
5) excellent	5.5	5.5
med.	3.3	3.4

18. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your Grade 8 students in your science area/room/laboratory?

1) none	29.8%
2) 1 - 5	56.0
3) 6 - 10	8.3
4) 11 - 15	3.3
5) more than 15	2.6

19. In your opinion how adequate are the science reading materials for Grade 8 students in your school library?

1) there is no school library	4.7
2) very inadequate	8.3
3) somewhat inadequate	33.2
4) satisfactory	42.5
5) very adequate	9.0
6) unfamiliar with materials	2.3
med	3.6

20. To what extent did you teach the new junior high science last year?

1) only old curriculum	10.1
2) majority old, some new curriculum	16.7
3) some old, majority new curriculum	29.9
4) only new curriculum	31.2
5) I did not teach science last year	12.1
med	3.3

21. In your opinion how useful is the approved Manitoba Department of Education curriculum guide for the science program you are presently teaching?

1) of no use	2.0
2) of little use	8.0
3) useful	48.7
4) very useful	40.0
5) unfamiliar with guide	1.3

22. Has implementing the new curriculum meant extra work for you?

1) too much extra work to implement	2.7
2) much extra work was required	49.3
3) some extra work was required	36.1
4) extra work was not required	5.8
5) have not tried to implement	6.1

If you checked 1, 2 or 3 above, what extra work was required?

____

____

23. If you had a choice, at which grade level would you prefer to teach science?

1) primary/kindergarten (K-3)	1.1
2) intermediate (4-6)	12.4
3) junior high (7-9)	60.7
4) senior high (10-12)	19.9
5) post secondary	2.6
6) none	3.4

24. As a rule, are you comfortable teaching science?

1) yes	80.7
2) no	4.9
3) in-between	14.4

25. How important do you think junior high science (7-9) should be in a student's schooling?

1) less important than all other subjects	0.7
2) less important than most other subjects	3.0
3) equal to other subjects	82.3
4) more important than most other subjects	13.0
5) more important than all other subjects	1.0

26. When did you receive your first teaching certificate?

19 76, 70, 68, 67 (Median 1968-7)

27. How adequately did your pre-service teacher education program in science prepare you for teaching scien

1) I had no teacher education in science	13.9
2) very inadequately	29.4
3) somewhat inadequately	30.7
4) adequately	22.1
5) very adequately	4.0

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28. How much emphasis SHOULD be placed on each of the following in preparing teachers to teach Grade 8 science? (Write in the appropriate number).

1 Minimum Emphasis	2 Minor Emphasis	3 Major Emphasis	4 Maximum Emphasis	5 Does not apply

	PRESERVICE	INSERVICE	
1) science as a way of thinking. . .	2.9	2.7	Median
2) techniques of teaching science. .	3.5	3.3	
3) science content	2.9	2.7	
4) history and philosophy of science	1.9	1.6	
5) psychology of learning.	2.5	2.1	
6) testing and evaluation in science	2.9	2.9	
7) survey of available curriculum materials	2.8	3.0	
8) how to develop curriculum materials	2.8	2.9	
9) lesson planning	3.0	2.4	
10) preparation of science materials.	2.9	2.9	
11) practice in teaching science. . .	3.2	2.5	
12) discussion of problems of science teaching.	2.7	3.0	
13) care and maintenance of equipment	2.6	2.6	
14) laboratory safety	3.2	3.3	
15) special education	2.1	2.1	
16) other (specify)________________	3.6	2.8	

29. How many courses in science education or methods have you taken?

1) none.	18.6
2) one	35.5
3) major/concentration in science education	37.2
4) other (specify)________________	8.8

30. When did you take your MOST RECENT science education or methods course?

19_76_, 77, 79, 78, 74 (Median 1974-9)

31. How many college/university courses (academic or content courses) have you had in each of the following areas of science?

	0	1-3	4-7	8 or more
1) Biology	21.7	54.3	12.0	12.0
2) Chemistry	26.6	51.1	21.0	1.3
3) Physics	38.4	49.3	11.0	1.4
4) Astronomy	65.8	33.7	0.5	0.0
5) Earth Science	32.9	49.6	12.3	5.3
6) Other (specify)______________	26.0	34.0	30.0	8.0

32. Do you have any other comments?
Please write your comments in the next column.

THANK YOU FOR YOUR ASSISTANCE.

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SURVEY OF GRADE 11 TEACHERS OF SCIENCE

Please check all items once only unless otherwise instructed.

1. Which science courses have you taught and are you teaching? (Check more than one if appropriate).

	This Year	Past Years
1) Elementary science (K-3)	0.0	2.2 %
2) Elementary science (4-6)	0.3	8.7
3) Science 7	5.6	26.5
4) Science 8	5.9	29.6
5) Science 9	24.9	47.7
6) Science 100	41.4	48.3
7) Science 101	29.9	45.2
8) Science 103	6.9	11.2
9) Science 203	4.4	8.1
10) Science 303	5.3	7.5
11) Physical Science 201	21.2	34.6
12) Physical Science 301	16.8	26.5
13) Physics 200	29.6	29.3
14) Physics 300	24.3	25.5
15) Chemistry 200	35.8	32.7
16) Chemistry 300	32.7	30.5
17) Biology 200,201	35.2	36.8
18) Biology 300, 301	30.8	29.9
19) Other (specify) ______	5.6	5.6

2. How much of your teaching time do you spend as a science teacher?

1) full-time science	56.0
2) part-time science	3.5
3) part-time science, part-time in one other subject area	29.4
4) part-time science, part-time in two or more other subject areas	9.2
5) part-time science, part-time counselling and/or administration	1.9

3. How many students are in your Grade 11 science class(es) this year?

	Largest	Average (or one class only)	Smallest
1) 20 or less	19.6	33.7	56.5
2) 21 - 24	13.2	28.6	23.4
3) 25 - 28	27.4	23.5	10.9
4) 29 - 32	28.8	10.6	8.2
5) over 32	11.0	3.5	1.1

4. How many hours per week, on the average, do you spend to prepare and mark for your science classes?

1) less than 1 hour	0.0
2) 1 - 2 hours	6.3
3) 3 - 4 hours	24.1
4) 5 - 6 hours	22.5
5) more than 6 hours	47.2

5. What procedure do you use for marking student's lab write-ups?

1) I don't mark any write-ups.	5.4
2) I mark all write-ups.	68.1
3) For each experiment I mark write-ups for a sample of the students	1.6
4) I mark each student's write-ups for a sample of experiments	24.9

6. On the average, how many minutes a week (5 days) do your grade 11 science students receive science instruction at present?

	Physics 200	Chem 200	Biol 200	Biol 201	Sci 203	PhSci 201
1) less than 100 mins.						
2) 100 - 199 mins.						
3) 200 - 299 mins.						
4) 300 - 399 mins.						
5) 400 - 499 mins.						
6) 500 - 599 mins.						
7) 600 - 699 mins.						
8) 700 - 799 mins.						
9) 800 or more						
10) not teaching this						
med.	3.8	3.8	3.9	3.8	3.9	3.9

7. What emphasis do you place on each of the following for your formal evaluation of Grade 11 students in science? (Write in the appropriate number from the scale below).

1	2	3	4	5
Minimum Emphasis	Minor Emphasis	Major Emphasis	Maximum Emphasis	Does not apply

	Median
1) teacher-made objective tests.	3.2
2) standardized objective tests.	1.6
3) subjective tests (essays, paragraphs, etc.)	1.8
4) laboratory/experiment write-ups	2.3
5) individual work contracts	1.4
6) oral and written reports.	1.4
7) projects (eg. for display).	1.3
8) oral tests.	1.2
9) student self reports.	1.1
10) anecdotal records of achievement.	1.2
11) general attitude in class	1.7
12) work habits	1.9
13) other (specify) ______	2.8

8. How often do you engage the students in your Grade 11 science classes in each of the following activities? (Write in the appropriate number from the scale below).

1	2	3	4	5
Hardly Ever (0, 1 or 2 times during course)	Occasionally (one out of four science class periods)	Often (every other period)	Frequently (3 out of 4 science class periods)	Very Frequently (almost every science class period)

1) carrying out experiments from a set of instructions	2.2
2) making up and carrying out their own experiments	1.1
3) discussing the possible errors in an experiment that has been completed.	2.3
4) listening to lectures.	3.1
5) making a graph from the data that the students get from an experiment	1.9
6) applying information to new problem situations	2.4
7) making guesses about the results of an experiment.	1.9
8) interpreting or explaining for themselves the results of an experiment	2.3
9) classifying objects or events	1.4
10) describing/reporting observations in their own words.	2.[illegible]
11) measuring in an experiment	2.4
12) doing worksheets	2.4
13) discussing results of an experiment with other students	2.1
14) copying notes from the blackboard/overhead projector.	2.5
15) working on problems at the end of a section in a book	2.6
16) memorizing scientific information.	1.6
17) doing investigations at home	1.1
18) reading from textbooks	2.0
19) doing research in the library.	1.2

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9. Which organization of school year does your school have?

1) trimester	0.3%
2) semester	70.2
3) regular full year	28.6
4) other (specify)	1.0

10. Do you have enough time to achieve your objectives with your science students?

1) more than enough time	1.3
2) enough time	41.0
3) almost enough time	36.9
4) not enough time	20.8

11. How adequate are the following physical facilities for teaching science in your school? (Please write the appropriate number from the following scale).

1	2	3	4	5
Very Inadequate	Inadequate	Adequate	Very Adequate	Does not apply

1) tables/counters	Median 3.2
2) lighting	3.4
3) storage space for science materials/equipment	3.1
4) amount of work space per student	2.9
5) plant/animal space	2.3
6) preparation room	2.9
7) storage/display space for student projects	2.2
8) audio-visual equipment	3.2
9) gas outlets	3.3
10) water outlets	3.2
11) electrical outlets	3.3
12) sink or drainage facilities	3.1
13) separate storage space for acids	2.7
14) locked metal storage space for volatiles	1.8
15) fume hood/closet	2.5

12. What safety equipment do you have available for use for teaching Grade 11 science? (Check all that apply)

1) fire blanket(s) - asbestos type	30.2%
2) fire blanket(s) - other types	37.7
3) fire extinguisher(s) - ABC type	72.3
4) fire extinguisher(s) - AB type	16.2
5) fire extinguisher(s) - other type (specify) ____________	12.8
6) master gas shut-off	86.9
7) master electrical shut-off	30.2
8) approved first aid kit	59.8
9) safety goggles, sufficient for whole class	78.5
10) master water shut-off	25.5
11) safety gloves	27.1
12) sand buckets and scoops	9.3
13) continuous flow eye wash stations	33.6
14) other (specify)	11.2
15) none of the above	0.9

13. How frequently is the safety equipment checked in your science area/room/laboratory?

1) never	2.3
2) less than once a year	11.4
3) once a year	50.2
4) more than once a year	35.8
5) I have no safety equipment	0.3

14. Overall, how do you rate the quantity and variety of the science equipment available to you?

	Quantity	Variety
1) very poor	1.9	2.3
2) poor	5.4	7.7
3) fair	26.3	29.3
4) good	52.2	48.9
5) excellent	14.2	11.9

15. Which of the following science activities take place in your school? (Check all that apply).

1) recreation science (either in school or extra-curricular clubs - lapidary, science, photography, nature study)	38.3
2) science fair	37.7
3) other (specify)____________	4.7
4) none	30.2

16. What kind of assistance are you given for teaching Grade 11 science, for example for cleaning up after science lessons, for preparing new lessons, for maintaining science equipment, etc.?

1) no assistance required	9.2
2) paid adult assistance	17.8
3) paid student assistance	11.6
4) volunteer assistance from parent	0.5
5) volunteer assistance from students	5.5
6) no assistance	55.8

17. On the average, how many times do you assign work to be done out of class to each Grade 11 science student in a week?

1) 0	3.5
2) 1 or 2 times	43.1
3) 3 or 4 times	44.1
4) 5	8.3
5) 6 or more	1.0

18. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your Grade 11 students in your science area/room/laboratory?

1) none	26.7
2) 1 - 5	57.6
3) 6 - 10	6.8
4) 11 - 15	2.9
5) more than 15	6.1

19. In your opinion how adequate are the science reading materials for Grade 11 students in your school library?

1) there is no school library	0.6
2) very inadequate	8.6
3) somewhat inadequate	25.6
4) satisfactory	45.7
5) very adequate	18.5
6) unfamiliar with materials	1.0

20. In your opinion how useful is the approved Manitoba Department of Education curriculum guide for the science program(s) you are presently teaching?

1) of no use	7.3
2) of little use	34.1
3) useful	48.4
4) very useful	7.0
5) unfamiliar with guide	3.2

21. If you had a choice, at which grade level would you prefer to teach science?

1) primary/kindergarten (K-3)	0.3
2) intermediate (4-6)	1.4
3) junior high (7-9)	1.4
4) senior high (10-12)	89.8
5) post secondary	5.5
6) none	11.7

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22. As a rule, are you comfortable teaching science?

1) yes.	93.1%
2) no	1.3
3) in-between	5.6

23. How important do you think senior high science (10 - 12) should be in a student's schooling?

1) less important than all other subjects	0.0
2) less important than most other subjects.	0.3
3) equal to other subjects.	63.0
4) more important than most other subjects.	34.5
5) more important than all other subjects	1.9

24. Rank the following purposes of Science 100 and Science 101 from most important (Rank 1) to least important (Rank 9).

Science 100 (101) should help students to:

	SCIENCE 100 RANK Median	SCIENCE 101 RANK
1) develop concepts and content important for preparing for Science 200 courses.	2.8	6.9
2) develop skills in the science processes important for preparing for Science 200 courses.	2.4	6.6
3) develop an understanding of the interaction between science, technology, and the individual (or society) as represented by the effect of discoveries upon consumer goods and rate of resource development	5.7	3.6
4) develop psychomotor skills necessary for first-hand investigations	4.8	4.9
5) develop general interpretative, computational and communication skills which are important to understanding data	3.1	4.5
6) train in safe laboratory practices	4.1	3.5
7) relate scientific concepts to everyday life.	5.2	3.0
8) develop general concepts and science skills from a number of sciences.	4.4	3.5
9) develop an interest in and appreciation of scientific problem-solving and scientific values.	3.1	3.5

25. When did you receive your first teaching certificate?

19 70, 71, 65, 63, 67 (Median 1967-3)

26. How adequately did your pre-service teacher education program in science prepare you for teaching science?

1) I had no teacher education in science.	4.1
2) very inadequately.	18.9
3) somewhat inadequately.	31.2
4) adequately	37.2
5) very adequately.	8.5
med	3.4

27. How much emphasis SHOULD be placed on each of the following in preparing teachers to teach Grade 11 science? (Write in the appropriate number).

1	2	3	4	5
Minimum Emphasis	Minor Emphasis	Major Emphasis	Maximum Emphasis	Does not apply

Median	PRESERVICE	INSERVICE
1) science as a way of thinking	2.8	2.5
2) techniques of teaching science	3.5	3.2
3) science content.	3.1	2.8
4) history and philosophy of science.	1.9	1.7
5) psychology of learning	2.7	2.3
6) testing and evaluation in science.	3.0	2.9
7) survey of available curriculum materials.	2.7	2.9
8) how to develop curriculum materials.	2.7	2.8
9) lesson planning.	2.9	2.2
10) preparation of science materials	2.9	2.7
11) practice in teaching science	3.5	2.1
12) discussion of problems of science teaching	2.8	3.1
13) care and maintenance of equipment.	2.5	2.5
14) laboratory safety.	3.3	3.2
15) special education.	1.9	2.0
16) other (specify)________________	3.6	3.5

28. How many courses in science education or methods have you taken?

1) none	3.9
2) one.	15.8
3) major/concentration in science education.	73.9
4) other (specify).	6.5

29. When did you take your MOST RECENT science education or methods course?

19 78, 72, 73, 79, 74 (Median 1972-7)

30. How many college/university courses (academic or content courses) have you had in each of the following areas of science?

	0	1-3	4-7	8 or more
1) Biology.	22.6	34.2	17.1	26.1
2) Chemistry.	4.8	49.5	38.1	7.6
3) Physics.	14.4	56.1	23.1	6.4
4) Astronomy.	63.5	35.8	0.6	0.0
5) Earth Science.	39.2	49.2	7.9	3.7
6) Other (specify)______________	23.2	39.1	20.3	17.4

31. Do you have any other comments?
Please use the reverse of this page to comment.

THANK YOU FOR YOUR ASSISTANCE.

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